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POTATO FORECASTING MODEL

(Working Paper 9/84)

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POTATO FORECASTING MODEL

Introduction

The Potato Forecasting Model presents annual (crop year) as well as quarterly estimates, simulation and forecast results for: production, domestic disappearance, price relationships, cash-receipts and trade. Simultaneous determination of both annual and quarterly information is provided by the model.

Given the annual characteristic of potato production plus the fact that some of the key variables, such as domestic disappearance and commercial inventories, are not available on a quarterly basis, it was initially essential to estimate all the equations of the model on an annual basis. Similarly, since the main objective of the model is to provide quarterly forecasts, it became necessary to "translate" and therefore to re-estimate these equations on a quarterly framework.

Major objectives are: 1- to provide a structural description of the Canadian potato sector and 2- to establish a quantitative framework for making regular quarterly forecasts that are consistent with both FARM and commodity specialists analysis.

There is no breakdown, at this stage, between seed and table potatoes, although it is recognized that from a market perspective each category represents in fact a distinctive "end-use". The model is split into two periodicities. The annual framework comprises 12 equations: ten of which are behavioral equations and the remaining two are identities. The quarterly version is made of 17 equations, with fifteen behavioral relations and two identities.

Most of the model's equations are national in scope, only the production bloc is disaggregated on a regional basis, that is: Atlantic, Central and Western Canada. Since the potato industry for each region is relatively different, such a "high" degree of aggregation is intended primarily to keep the model at a manageable size, but may present some drawbacks in terms of specification.

This study is divided into five sections: 1- a brief presentation of the canadian potato industry setting and a description of the model structure, 2- an analysis of the equation specifications, 3- data analysis - mainly on problems encountered and limitation, 4- presentation of the empirical results from ordinary least squares estimation, and 5- validation of the model using intra- sample and extra-sample simulation measures. The conclusion of the study will be a brief assessment and some proposals for future development.

It is acknowledged that the present study is oriented toward the presentation of the results in the form of "applied research". Practical problems such as the consistency and the reliability of the model forecasting structure or the translation of the industry (observed) structure into a modelling framework received major attention. It is not intended that a detailed theoretical analysis be produced nor that econometric comparisons be made with other models.

1. CHARACTERISTICS OF THE POTATO SECTOR

(a) Industry Setting

Although no major structural changes in production and marketing techniques have occured; over the period 1965-82, the Canadian potato sector has experienced both a rapid increase in the volume of production and a parallel decrease in prices. Similarly, changes in net trade, characterized by a more rapid growth in total exports, have been experienced. By and large, the sector demonstrates significant fluctuations in production, prices, exports and imports, only domestic demand seems relatively stable.

Contrary to other major agricultural sub-sectors (like poultry, dairy, etc.), there is at present no national agency or supply management program that controls the production and marketing of potatoes in Canada. It is observed, however, that various potato producers' groups manifest their desire to see the establishment of some sort of system such as a "Canadian Potato Marketing Board". However such a proposal is yet to be implemented. Meanwhile the potato sector is more likely to continue with significant fluctuations in both production and prices.

Recent sector analysis by the Horticulture Unit indicates some geographic restructuring of potato production in Canada. Nova Scotia, Quebec, Ontario, Saskatchewan and Alberta have experienced a significant decline in their area for potato production over the period of 1965 to 1982 (Table 1). Prince Edward Island and Manitoba have had a significant growth in area, while in British Columbia and New Brunswick the area in potatoes has remained relatively constant.

TABLE 1. CANADIAN POTATO AREA BY PROVINCE 1966/67 TO 1982/83 (Hectares)

Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
1966/67	N/A	21,080	2,510	26,260	30,230	21,080	9,910	3,440	10,280	4,250	129,050
1967/68	N/A	20,640	1,980	25,090	28,730	19,420	10,720	3,240	9,060	4,010	122,900
1968/69	N/A	21,450	2,020	24,690	28,330	18,210	10,720	3,040	9,870	4,370	122,700
1969/70	N/A	20,230	1,740	25,900	27,520	18,410	11,740	2,910	10,930	4,130	123,510
1970/71	N/A	20,640	1,820	24,690	27,110	19,220	13,350	3,560	12,950	4,450	127,800
1971/72	482	18,940	1,420	24,040	19,220	16,230	13,230	1,340	10,560	3,680	109,140
1972/73	526	15,780	1,420	20,640	18,620	17,440	8,900	1,210	9,310	4,650	98,500
1973/74	425	17,000	1,540	20,640	20,230	16,920	12,140	1,210	9,310	5,670	105,080
1974/75	473	21,040	1,580	22,660	21,450	18,490	14,160	1,010	9,310	3,640	113,830
1975/76	461	18,620	1,460	21,040	20,030	17,890	12,950	1,010	7,280	4,050	104,790
1976/77	473	20,880	1,500	22,460	17,400	18,410	13,960	810	6,560	4,370	106,820
1977/78	482	22,260	1,540	23,070	17,890	19,470	14,970	770	6,920	4,610	111,970
1978/79	453	22,660	1,540	23,470	17,890	17,970	14,970	810	6,560	4,170	110,490
1979/80	445	24,690	1,580	22,660	18,090	18,210	14,970	890	7,000	4,250	112,790
1980/81	405	22,660	1,620	21,040	17,000	16,550	15,990	930	6,600	3,640	106,430
1981/82	405	25,900	1,540	21,850	17,200	15,820	16,550	1,010	6,720	3,520	110,520
1982/83	320	27,920	1,620	21,850	17,810	15,820	15,990	1,050	7,280	3,640	113,310

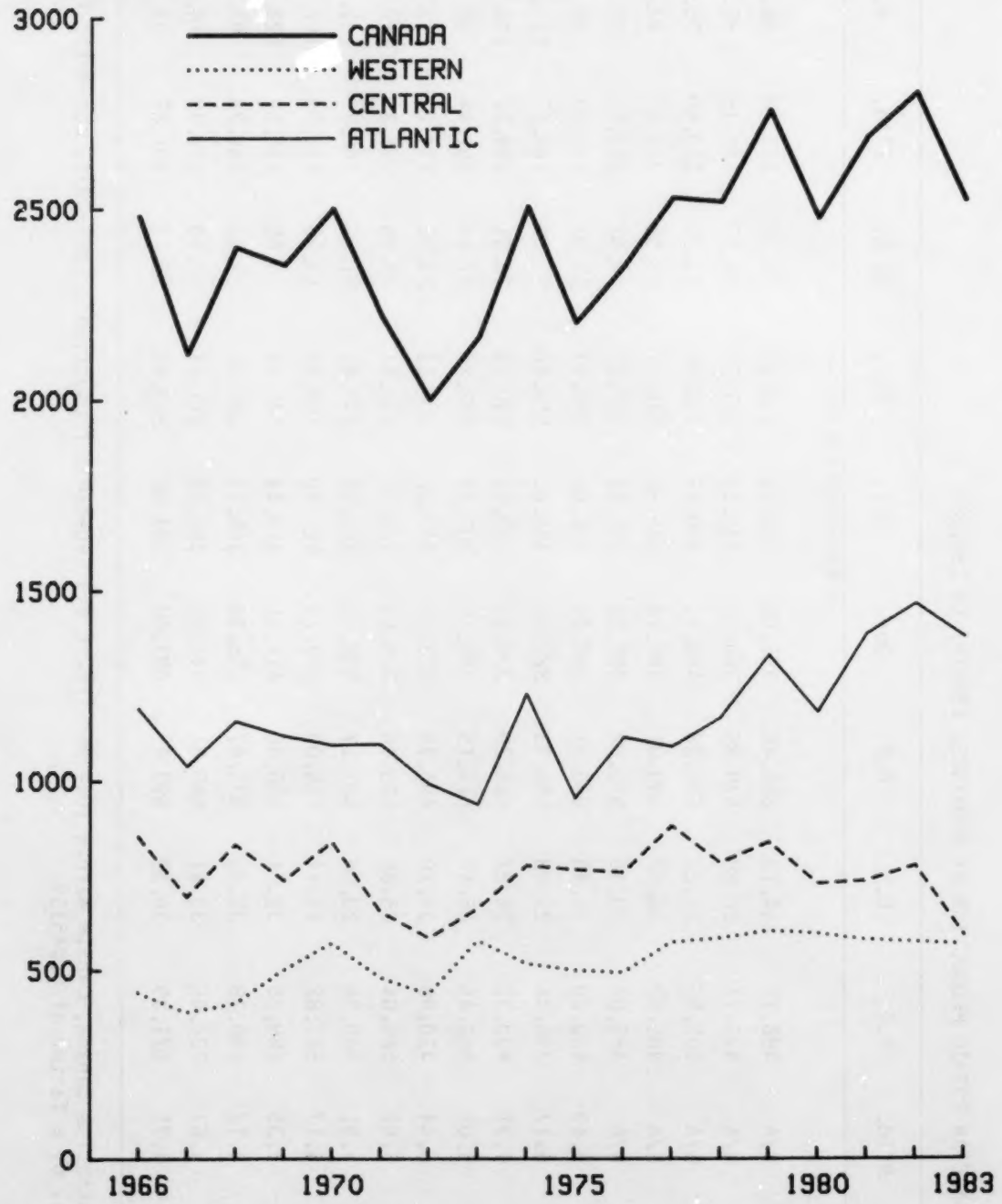
Source: Statistics Canada, CANISM matrix 1044, retrieved 15 Sept. 1982, (1964-69) and 14 June 1983 (1970-80) and cat. no. 22-003 (1981 to date). Data converted from acres by a factor of 0.4046856 and rounded to reflect the appropriate number of significant digits shown in Imperial units.

TABLE 2. CANADIAN POTATO PRODUCTION BY PROVINCE, 1966/67 TO 1982/83

Crop-Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
						- thousand tonnes -					
1966/67	N/A	488.79	44.13	655.44	397.80	453.73	138.89	28.08	177.22	96.12	2,480.20
1967/68	N/A	435.77	30.80	570.85	360.06	333.12	131.54	26.13	145.15	86.18	2,119.59
1968/69	N/A	501.95	27.22	625.28	440.71	390.27	136.08	31.75	149.69	95.25	2,398.19
1969/70	N/A	485.80	30.62	599.01	349.18	386.96	172.37	25.99	204.12	97.52	2,351.56
1970/71	N/A	465.02	30.93	595.02	369.22	468.61	167.83	40.82	258.55	104.33	2,500.34
1971/72	5.40	423.29	25.40	633.71	290.84	361.60	185.97	14.97	181.44	96.75	2,219.38
1972/73	6.17	396.44	27.08	550.93	227.02	354.85	113.40	21.55	185.97	113.40	1,996.80
1973/74	4.31	433.32	25.27	465.20	329.99	329.53	199.58	26.31	204.12	145.15	2,162.70
1974/75	5.62	562.45	25.67	624.19	382.15	389.73	222.26	17.24	181.44	92.99	2,503.74
1975/76	6.44	420.98	24.18	490.79	323.32	437.26	204.12	23.81	154.22	113.40	2,198.52
1976/77	5.62	565.04	25.85	505.44	324.68	429.37	190.51	19.96	163.29	117.03	2,346.80
1977/78	5.81	540.36	28.26	503.17	388.00	488.07	249.48	21.27	168.78	131.59	2,254.79
1978/79	6.17	561.82	29.44	555.02	357.79	421.30	308.44	19.23	151.32	102.78	2,513.31
1979/80	6.35	689.25	32.21	590.40	414.81	418.44	281.95	18.55	176.58	123.83	2,752.35
1980/81	4.17	590.78	33.02	525.67	358.38	365.73	285.80	19.82	189.28	97.98	2,470.67
1981/82	5.67	734.46	33.61	600.84	341.80	390.18	311.67	17.58	172.43	74.98	2,683.21
1982/83	4.35	821.39	36.33	593.47	387.00	384.86	263.40	22.41	191.87	93.89	2,798.98

Source: Statistics Canada, CANSIM matrix 1044 and "Fruit and Vegetable Production", (#22-003), converted from thousand cwt. by a factor of 0.045359.

FIGURE 1 HARVESTED PRODUCTION OF POTATOES (THOUSAND METRIC TONNES).



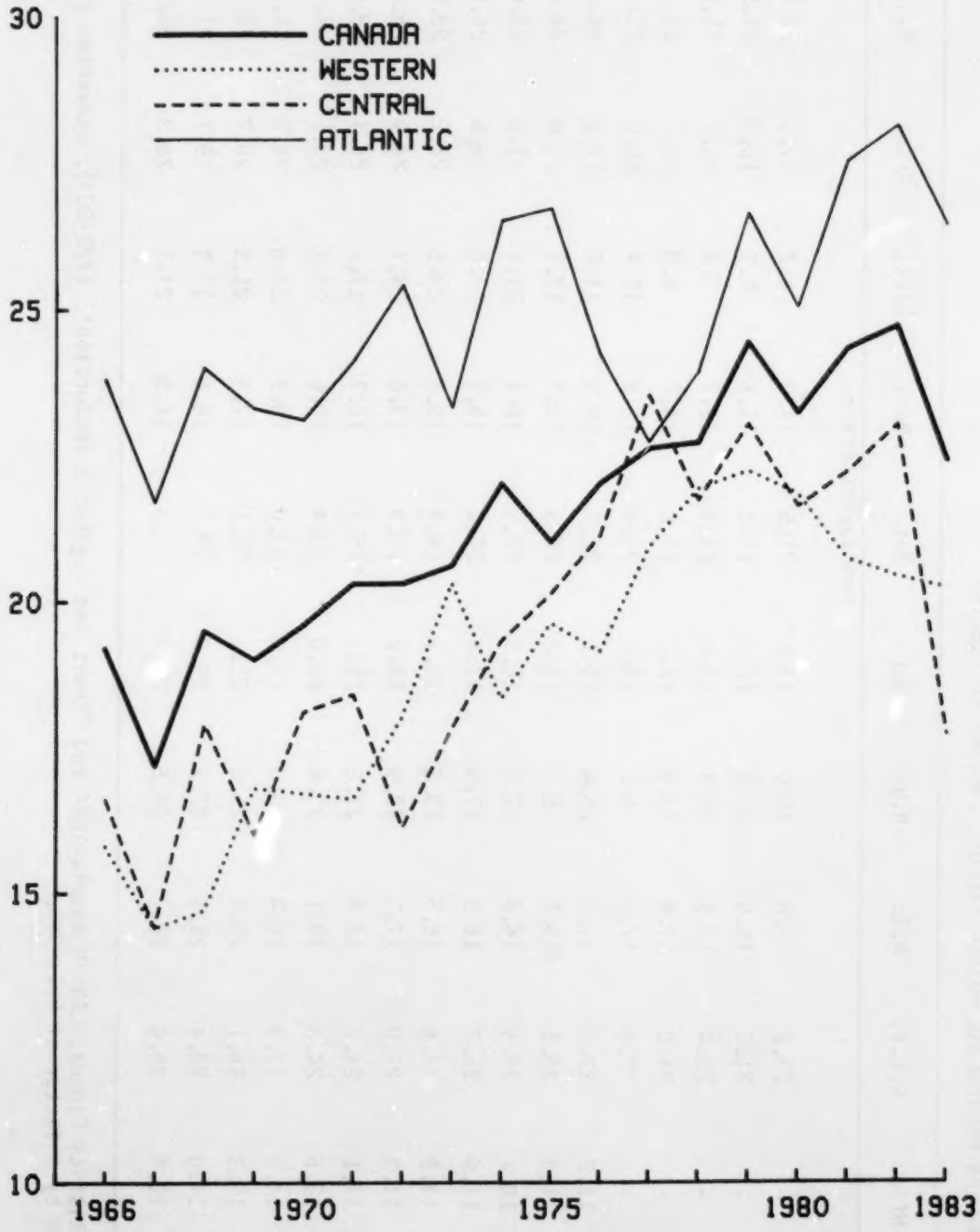
SOURCE: Statistics Canada, CANSIM matrix 1044 and 'Fruit and Vegetable Production', (822-003), converted from cwt by a factor of 0.045359

TABLE 3. CANADIAN PROVINCIAL POTATO YIELDS, 1966/67 TO 1982/83

Crop-Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
						- tonnes/hectare -					
1966/67	-	23.2	17.6	25.0	13.1	21.5	14.0	8.2	17.3	22.6	19.2
1967/68	-	21.1	15.5	22.8	12.6	17.2	12.2	8.1	16.0	21.5	17.2
1968/69	-	23.4	13.5	25.3	15.6	21.4	12.7	10.4	15.1	21.7	19.5
1969/70	-	24.0	17.6	23.9	12.7	21.1	14.7	9.0	18.7	23.7	19.0
1970/71	-	22.5	17.0	24.1	13.7	24.4	12.6	11.4	20.0	23.4	19.6
1971/72	11.2	22.3	17.9	26.4	15.1	22.3	14.1	11.2	17.2	26.3	20.3
1972/73	11.8	25.1	19.1	26.7	12.2	20.3	12.7	17.7	20.0	24.4	20.3
1973/74	10.1	25.5	16.4	22.5	16.3	19.5	16.4	21.7	21.9	25.6	20.6
1974/75	11.9	26.7	16.3	27.5	17.8	21.1	15.7	17.0	19.5	25.5	22.0
1975/76	13.9	22.6	16.6	23.3	16.1	24.4	15.8	23.5	21.2	28.0	21.0
1976/77	11.9	27.0	17.3	22.5	18.7	23.3	13.6	24.7	24.9	26.8	22.0
1977/78	12.1	24.3	18.4	21.8	21.7	25.1	16.7	27.7	24.4	28.5	22.5
1978/79	13.6	24.8	19.1	23.6	20.0	23.4	20.6	23.7	23.1	24.7	22.7
1979/80	14.3	27.9	20.4	26.0	22.9	23.0	18.8	20.8	25.2	29.1	24.4
1980/81	10.3	26.1	20.4	25.0	21.1	22.1	17.9	21.3	28.7	26.9	23.2
1981/82	14.0	28.4	21.9	27.5	19.9	24.7	18.8	17.4	25.7	21.3	24.3
1982/83	13.5	28.0	24.7	26.6	21.7	24.3	16.5	21.3	26.3	25.8	24.3

Source: Statistics Canada, CANSIM matrix 1044 and "Fruit and Vegetable Production", (#22-003), converted from cwt. per acre by a factor of 0.112085.

FIGURE 2 AVERAGE YEARLY YIELD, (TONNES/HECTARE)



SOURCE: Statistics Canada, CANSIM matrix 1044 and 'Fruit and Vegetable Production', (922-003); The series were obtained by dividing production by area.

Technological changes (e.g. through improved seed, more efficient farm chemicals) and better management practices seem to be among the key explanatory factors of the increases in production. Although yields have increased significantly over the period 1965-82, more recently that increase is limited (Figure II).

It is Manitoba and P.E.I. that show the biggest gain in total production. Manitoba has nearly doubled production between 1965 and 1982 with most of the volume targeted for the processing sector - while P.E.I. has increased their average production by approximately 33 percent during that same period (Table 2).

The average farm price received by producers remained relatively constant and low between 1966 and 1971. Since then, prices have been very volatile. Farm prices for potatoes reached significant levels in 1973, 1975 and more recently in 1980, 1981 and 1982. On the other hand, farm prices were well below average for such years as 1972, 1974 and 1979 (Table 4), which explain the A.S.B. subsidies received by producers particularly in 1974 and during the period 1976-79.

The trade pattern for fresh potatoes (both seed and table) did not vary between 1965 and 1982. Most of the exports and almost all the imports were "to" and "from" the U.S.A.; although Canada also exports a significant volume of seed and some table potatoes to the rest of the world, mainly to the Caribbean area, North Africa and Southern Europe.

TABLE 4. CANADIAN POTATO CONSUMPTION, FARM VALUE AND AVERAGE FARM PRICE, 1966 TO 1982

	Per Capita Consumption (kg)	Farm Value[1] ($ 000)	Average Farm Price[1] (¢/kg)
1966	62.72	78,514	3.35
1967	77.35	80,451	4.10
1968	67.49	82,011	3.68
1969	75.68	110,473	5.03
1970	68.19	109,371	4.76
1971	72.15	83,780	4.06
1972	72.62	143,487	7.69
1973	68.75	240,929	11.79
1974	66.44	137,992	6.01
1975	73.65	230,014	11.33
1976	66.81	193,507	8.71
1977	72.43	157,798	7.18
1978	72.50	178,158	8.15
1979	78.66	162,952	7.07
1980	70.87	352,390	16.16
1981	64.79	278,961	11.97
1982	69.72	243,606	10.69

[1]Excludes Agricultural Stabilization Board Subsidies that were paid in 1974 and in the period 1976-79, inclusive.

Sources: Statistics Canada, "Apparent Per Capita Food Consumption in Canada, Part 2" (January 1984), and
Statistics Canada CANSIM matrix 1044, and "Fruit and Vegetable Production" Catalogue No. 22-003, and
Agriculture Canada, "Handbook of Food expenditures, prices and consumption" (September 1983).

The North-South (i.e. Canada - U.S.) potato trade pattern reflects to some degree the structure of domestic movements of the commodity. Shipments of potatoes between Eastern and Western Canada are quite limited, the main domestic movements of potatoes are from the Atlantic region to the major markets in Central Canada. Provinces in Western Canada like British Columbia receive U.S. imports primarily from Idaho and Washington State. Meanwhile a significant part of the exports from Atlantic Canada is shipped to markets in the North-Eastern U.S.A.

Marketing observations suggest that factors other than prices and exchange rates influence export and import demand for potatoes. Factors like seasonal availability (for example: early spring and summer potatoes are imported into Canada from the U.S. at periods when canadian stocks are usually at their lowest levels), as well as quality of the early U.S. table stock vis-à-vis stored domestic stock seem to play an important role in the determination of the structure of the potato trade between Canada and the U.S.

Although potatoes are a perishable commodity, commercial inventories of fresh potatoes are still a major element in the adjustment process of potato markets. There are indications that these inventories serve both transaction and speculative objectives. Commercial inventory behavior is characterized by very high levels of stocks in the middle of the fourth quarter and then by continous declines to levels judged nil in the third quarter of the next calendar year.

Recently, there have been suggestions and proposals for the establishment of an Eastern Canada Potato Marketing Agency in order to regulate supply and to stabilize price; which reflect general concerns about the structural instability of the Canadian potato industry and the declining market price for potatos.

(b) Model Structure

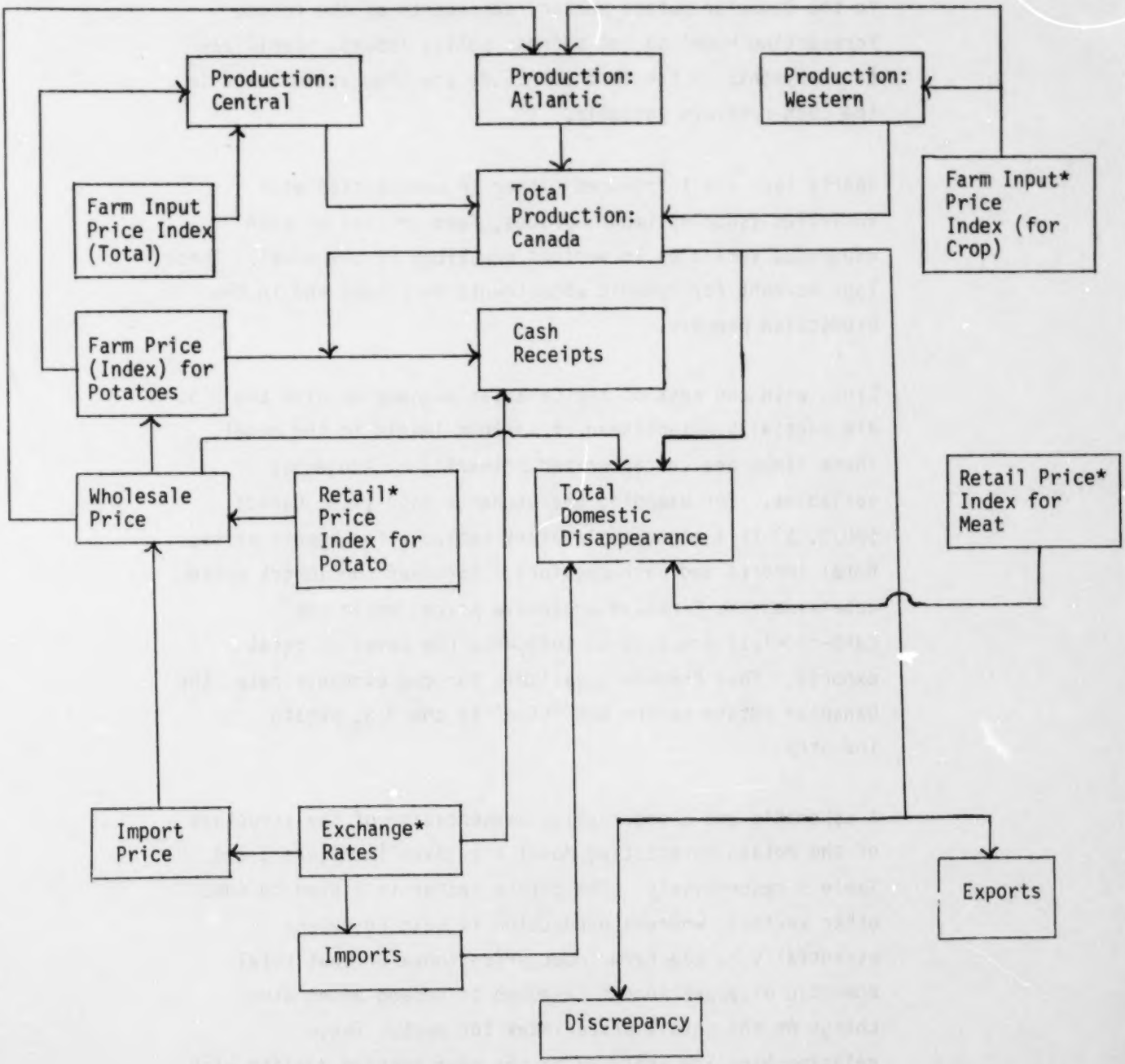
The structure of the Potato Forecasting Model translates in a "global manner" the important characteristics of the canadian potato industry. That is to say that the model was developed along structural considerations rather than from theoretical "concepts". However, it should be pointed out that the final shape of the model was also dictated by advice from commodity specialists and by practical estimation and data problems.

For example, certain structural links are absent in the model framework due to the lack of data for: 1) commercial inventories, 2) separate demand from the processing industry, 3) expected potato area, 4) relative costs of various inputs and 5) weather information. Similarly, the exclusion of U.S. supplies, demand or prices is based on practical forecasting problems that were encountered.

Prevailing marketing practices explain why import prices (together with retail prices) determine wholesale prices for potatoes, which in turn determine the farm prices for potatoes. This is the converse to the traditional hypothesis on price transmission mechanisms.

Concurrently, total domestic disappearance does not reflect the standard hypothesis. Since this variable includes both final and derived demands for potatoes, it is the wholesale price rather than the retail price of potatoes that determine the relative level of total domestic disappearance of potatoes.

FIGURE 3. SCHEMATIC REPRESENTATION OF THE CANADIAN POTATO INDUSTRY



(*) Exogenous variables to the model.

(**)The time trend parameter does not appear explicitly in this schematic representation.

Since there is no direct and formal governmental intervention in the Canadian potato sector, components of the Potato Forecasting Model do not address policy issues. Stabilization payments in the form of A.S.B. are thus assimilated in the cash-receipts variable.

Yearly lags are introduced either in conjunction with variables (such as import prices, farm prices) or with exogenous variables in various equations of the model. These lags account for dynamic adjustments in prices and in the production process.

Links with the rest of the Canadian economy or with the U.S. are partially established at various levels in the model. These links are characterized primarily by exogenous variables. For example, the exchange rate (i.e. Canada $/U.S. $) is a major explanatory variable for import price, total imports and cash-receipts. Moreover the import price determines the Canadian wholesale price, while the cash-receipts are said to influence the level of total exports. Thus through a variable for the exchange rate, the Canadian potato sector was "tied" to the U.S. potato industry.

A schematic and a descriptive presentation of the structure of the Potato Forecasting Model are given in Figure 3 and Table 5 respectively. The potato sector is linked to some other sectors, whereas production is said to depend essentially on the farm input price index or that total domestic disappearance is assumed to depend among other things on the retail price index for meat. These relationships are analysed in the next section dealing with equation specification.

2. Equation Specification

In the absence of comparative econometric analysis of the Canadian potato sector as a whole and the lack of certain information (particularly with regard to the world potato situation), the model is primarily specified on the basis of ad hoc considerations or experimental procedures.

Similarly, data limitations affect the "final" framework of the model specification. For example: The Demand bloc comprises of only one single equation, that for fresh table and processing potatoes, since available data for the demand for seed potatoes was "imprecise" while that for the processing industry is combined in total disappearance. In the production bloc, area and yield equations were deleted because data on expected potato area and on weather conditions were considered incomplete for forecasting purposes (see Section(3) on Data).

The seasonal character of production and marketings, as well as the perishable nature of potatoes, have had an important impact on specification. For example, since there are no carryovers in inventory for potatoes from one crop-year to another, (annual stocks are either too low or nil by the third quarter of each year); the behavior of commercial inventory holdings is not directly assessed. Those inventories together with cullage and seed are integrated in a discrepancy variable.

All the equations are structured to reflect either a crop-year or a quarterly framework. Whether annually or quarterly, the "economic" structure of the equations remains the same.

The model is specified so that crop-year estimates and forecasts can be obtained as well as quarterly estimates and forecasts for certain variables. Two sets of estimations were obtained using respectively annual and quarterly data, but retaining the same equation specifications (except for equations 13 to 17 of the quarterly framework).

The treatment of retail prices and farm input prices as exogenous variables may be rationalized to the extent that these variables are "already" endogenized by the FARM model.

The influence of the U.S. and the Rest of the World (R.O.W.) markets on the Canadian potato sector is not clearly apparent in the current specification - basically due to the exclusion of key "non-Canadian" variables from the model. The fact that variables for exchange rates and to a lesser degree for import price (as well as domestic disposition conditions) are the only factors that determine the interaction between Canadian and foreign markets (specially the U.S. market) is evidently limiting. A schematic representation of the specification of the model's equations is shown in Table 4. Finally, a policy variable does not appear in the model; even though a parameter such as the previous U.S. quota on Canadian potatoes seems relevant to the trade component of the model.

TABLE 5. REPRESENTATION OF VARIOUS COMPONENTS AND CLASSIFICATIONS OF ENDOGENOUS VARIABLES IN THE POTATO SECTOR

Components		Endogenous Variables
Production	(QP02A)	- Production of potatoes (harvested), Atlantic Canada
	(QP02)	- Production of potatoes (harvested), Central Canada.
	(QP01)	- Production of potatoes (harvested), Western Canada.
Demand	(DP03C)	- Total Domestic Disappearance of fresh table potatoes, Canada, (on a crop-year basis)
	(DP03)	- Total Domestic Disappearance of fresh table potatoes, Canada, (on a quarterly basis).
Prices	(IMPP03C)	- Import Prices for fresh potatoes, Canada, (on a crop-year basis).
	(IMPP03)	- Import prices for fresh potatoes, Canada, (on a quarterly basis).
	(WPP03C)	- Wholesale Prices for table potatoes, Canada, (on a crop-year basis).

- continued -

TABLE 5. (Conclusion)

Components		Endogenous Variables
	(WPP03)	- Wholesale prices for table potatoes, Canada (on a quarterly basis).
	(FPIP03C)	- Farm Price (index) for potatoes, Canada, (on a crop-year basis)
	(FPIP03)	- Farm Price (index) for potatoes, Canada, (on a quarterly basis).
Cash Receipts	(CRP03C)	- Total cash receipts from potato production, Canada, (on a crop- year basis).
	(CRP03)	- Total cash receipts from potato production, Canada, (on a quarterly basis).
Trade	(EXP03C)	- Total exports of fresh potatoes, Canada, (on a crop-year basis)
	(IMP03C)	- Total imports of fresh potatoes, Canada, (on a crop-year basis).
Identities	(QP03)	- Total production (harvested), Canada
	(DISCP03C)	- Discrepancy variable.

(a) Production

The Production bloc comprises four equations, three of which are behavioural and the other an identity. For structural purposes the bloc was disaggregated along a regional basis. It should be noted that potato production has a different economic significance in each of the three regions. While in Atlantic Canada, potatoes are a major crop and represent the key agricultural traded commodity, their relative importance is limited in Western Canada.

For each region, it appears that potato production reflects different parameters. For the Atlantic Provinces where the bulk of production is marketed through the main Eastern markets, Production (QP02A) is said to depend on the wholesale price for potatoes lagged (WPP03(-1)), a time trend variable for technical change, and the farm input price index for crop production lagged (FIPCOP3C(-1)).

For Central Canada, potato production (QP02) depends on the price of the inputs lagged (FIPI3C(-1)), the farm price of the output lagged (FPIP03(-1)), and a time trend for technical change. As for Western Canada, production (QP01) depends primarily on the price of the inputs lagged (FIPCOP3(-1)) and a time trend variable; this attests to a certain degree the fact that potatoes are a relatively "minor crop" in Western Canada and therefore less sensitive to variations in the price of the output. Finally, the total harvested production for Canada is directly derived through the summation of the regional productions.

(b) Demand for Potatoes

The Demand bloc is "restricted" to one single equation, that for table and for processing use; primarily because "specific" data on the demand for potatoes from the processing industry is confidential. Moreover, the demand for seed-use is not "precise" since some potatoes classified as seed may end up as table potatoes. Total domestic disappearance (i.e., table and processing use) (DP03C) is a function of wholesale price (WPP03C) and the price of a complement: that of meats (RPMT3C).

(c) Price Determination

The price determination bloc is made up of three major price levels: import, wholesale and farm. For reasons mentioned earlier, the retail price for potatoes is exogenous. Since the three market levels are related by supply conditions, the three prices are linked. Moreover, in the potato sector it appears that it is the import price (IMPP03C) that "drives" the wholesale price (WPP03C), which in turn determines the farm price (FPIP03C).

It is generally accepted that where one price variable generates a second variable, a behavioral structure for the primary variable, (in this case: IMPP03C), is required but that the second price variable can be derived strictly or partly from it by using some form of linkage equations.

From the above consideration, the Price determination bloc reflects a behavioral equation for the import price of potatoes (IMPP03C) which depends on the Canadian vs U.S exchange rates (ER34C), (i.e., the bulk of Canadian imports of potatoes are from the U.S.), and the lagged endogenous variable (IMPP03C(-1)).[2]

The wholesale price (WPP03C) is specified as a function of the import price (IMPP03) and changes in the retail price (RPP03C). Finally, farm price (FPIP03C) is assumed as a function of the change in the Wholesale price (WPP03C) and the lagged endogenous variable (FPIP03C(-1)).

(d) Cash Receipts

The Cash Receipts component was established at the national level, primarily for simplicity but also for convenience with the FARM forecast where only national farm cash receipts are considered. In the equation for cash receipts from potatoes, the variable (CRP03C) depends on total production (QP03) times the farm price for potatoes (FPIP03C), as well as on the Canadian vs. U.S. exchange rates (ER34C). The rationale behind the introduction of the exchange rates parameter as an explanatory variable is based on the fact that the Canadian potato sector is structurally linked to the U.S. potato market. A change in exchange rates directly affects the level of cash receipts for potato.

(e) Trade (Imports and Exports)

The equations for imports and exports include both seed and table potatoes. Such an aggregative approach is apparently inadequate in view of the fact that seed and table potatoes are in "principle" two different products aiming at two specific markets. However, separate equations for trade in seed require a set of data on world price, international supplies and disposition of seed potatoes, which are not readily available.

In light of this data constraint, total aggregate imports[3] (IMP03C) and total aggregate exports (EXP03C) were defined. Total imports for all potatoes (IMP03C) are

TABLE 6A. MODEL SPECIFICATIONS (CROP YEAR FRAMEWORK)

Variable (endogenous)	Equations
Production (Western):	QP01C = f(FIPCOP3C(-1), TIME)
Production (Central):	QP02C = f (FIPI3C(-1), FPIP03C(-1), TIME)
Production (Atlantic):	QP02AC = f(TIME, WPP03C(-1), FIPCOP3C(-1))
Demand:	DP03C = f(WPP03, RPMT3C)
Import Price:	IMPP03C = f(ER34C, IMPP03C(-1))
Wholesale Price:	WPP03C = f(IMPP03C, DEL(1: RPP03C))
Farm Price:	FPIP03C = f(DEL(1: WPP03C), FPIP03C(-1))
Cash Receipts:	CRP03C = f(FPIP03C*QP03C, DEL(1: ER34C))
Total Imports:	IMP03C = f(ER34C, DP03C, TIME)
Total Exports:	EXP03C = f(CRP03C(-1), QP03C(-1))
Total Production:	QP03C = QP01C + QP02C +QP02AC
Balance Sheet Identity	QP03C + IMP03C = DP03C + EXP03C + DISP03C

TABLE 6B. MODEL SPECIFICATIONS (QUARTERLY FRAMEWORK)

Variable (endogenous)	Equations
Production (Western):	QP01 = f(JS3*(FIPCOP3C(-4), TIME4))
Production (Central):	QP02 = f(JS3*(FIPI3C(-4), FPIP03C(-4), TIME4))
Production (Atlantic):	QP02A = f(JS3*(TIME4, WPP03C(-4), FIPCOP3C(-4))
Demand (yearly):	DP03C = f(JS3*(WPP03C, RPMT3C))
Demand (quarterly):	DP03 = f(JS3*DP03C, JS4*DP03C(-1), JS1*IMPP03C(-2), JS2*IMPP03C(-3))
Import prices (yearly):	IMPP03C = f(JS3*(ER34C, IMPP03C(-4))
Import prices (quarterly):	IMPP03 = f(JS3*IMPP03C, JS4*IMPP03C(-1), JS1*IMPP03C(-2), JS2*IMPP03C(-3))
Wholesale price (yearly):	WPP03C = f(JS3*(IMPP03C, DEL(4: RPP03C))
Wholesale price (quarterly):	WPP03 = f(JS3*WPP03C, JS4*WPP03C(-1), JS1*WPP03C(-2), JS2*WPP03C(-3))
Farm price (yearly):	FPIP03C = f(JS3*(DEL(4: WPP03C), FPIP03C(-4))
Farm price (quarterly):	FPIP03 = f(JS3*FPIP03C, JS4*FPIP03C(-1), JS1*FPIP03C(-2), JS2*FPIP03C(-3))
Cash Receipts (yearly):	CRP03C = f(JS3*(FPIP03C*QP03C, DEL(4: ER34C))
Cash Receipts (quarterly):	CRP03C = f(JS3*CRP03C, JS4*CRP03C(-1), JS1*CRP03C(-2), JS2*CRP03C(-3))
Total Imports (yearly):	IMP03C = f(JS3*(ER34C, DP03C, TIME4))
Total Exports (yearly):	EXP03C = f(JS3*(CRP03C(-4), QP03C(-4))
Total Production:	QP03 = QP01 + QP02 + QP02A
Balance Sheet Identity:	QP03 + IMP03C = DP03C + EXP03C + DISCP03C

said to depend on the exchange rates (ER34C) on domestic disappearance (DP03C) and on a time trend variable (TIME). Concurrently, total exports for all potatoes (EXP03C) are assumed to be a function of total Canadian harvested production lagged one year (QP03(-1), and of total cash receipts lagged (CRP03(-1)).

(f) Discrepancy Variable

As mentioned earlier, within a quarterly representation, commercial inventory depletes to insignificant levels at the third quarter of each year. Although stocks seem to play a significant role in the equilibrium adjustment of the potato market, their perishable nature and no yearly carryovers resulted in the inclusion of such stocks in a discrepancy variable. Concurrently, cullage is also assimilated to that discrepancy variable for reasons of simplicity. The discrepancy variable is derived residually through the balance sheet identity.

3. Data Limitations

Data limitation and precarious forecasts for certain key parameters represented major constraints in the construction and specification of the potato model. In fact, the range of potential specification "trials" was restricted, simply because reliable forecasts for U.S. supply and demand for potatoes were not available.

Another major problem encountered is the lack of specific data information on the grades and quality levels for potatoes. As a commodity, potatoes are marked by heterogeneous characteristics. Although all potatoes are similarly grown, certain physical characteristics (i.e., size, color, uniformity, high or low gravity, etc.) differentiate types and grades of potatoes in the marketplace, and hence their price or end use.

Moreover, it appears that not all these "various" types are complete (or absolute) substitutes to each other.

For example, round red potatoes, because of their low specific gravity (i.e, relatively higher water content) are best suited for boiling; while Russet potatoes, because of their high specific gravity are aimed at baking for the restaurant trade. Characteristics of this sort usually dictate the price pattern at the market level or the consumer's preference.

The absence of quantity information on types and grades of potatoes constitutes a major handicap, particularly in light of the fact that such parameters affect not only the domestic market but also trade patterns with the U.S. It has been pointed out that "quality" factors (i.e., more uniform size requirements and more appealing appearance) rather than "average prices" contribute to the competitiveness of Canadian potatoes in the U.S.

Difficulty is apparent in dealing with weather data in conjunction with the Yield equations. The use of average quarterly precipitation (i.e., average rainfall) as the sole weather factor is far from appropriate, as the potential growth of the potato crop depends on a combination of environmental factors. These include the potential evapotranspiration of the soil, the frequency of daily minimum temperatures, the daily duration of bright sunshine and the total or average precipitation.

Although a Climatic Moisture Index (CMI) can be derived for specific locations, its usefulness within a quarterly or annual model is not absolute; because the consumptive uses of water and sunshine vary with the different stages of development of the potato crop.

Moreover, there is an additional problem in handling a CMI, that of forecasting such a complex index. These data considerations explain the rationale for deleting the Yield equations and for restricting the Production bloc to economic and time trend parameters.

The data situation for commercial inventory also raised various difficulties. First, some of the potatoes held in stocks are classified as seed but in fact may end up as table potatoes; thus creating a problem in the interpretation of the nature of these inventories. It should be noted that knowledge of the "end use" intention of stock holdings is critical in the assessment of market behavior for such inventories.

Data on the "aggregated" commercial inventory of potatoes are published by Agriculture Canada on a monthly basis but for only seven months of the crop year. Stocks are judged by either being too low or nil for the remaining five months. Concurrently Statistics Canada provides data for commercial inventories of potatoes on a yearly calendar basis, with beginning and ending inventories assessed respectively at January 1 and December 31st.

While Agriculture Canada's data on the inventory of potatoes are incomplete (with missing data for third quarters), the data from Statistics Canada do not reflect the seasonal pattern. Therefore, the two series have a limited use in the present context.

As mentioned earlier, there was great difficulty in obtaining specific data on processed potatoes. In fact, Statistics Canada does not make public statistical information on the Food Processing Industry's demand and supply of potatoes and products. (One of the major manufacturers objects to the publication of such data).

Data for the wholesale prices of potatoes are based on Agriculture Canada, Market Information Service, "Crop and Seasonal Price Summaries". The final series were derived from a simple average of the reported prices for two grades of table potatoes in three major cities: No. 1 White potatoes at Montreal and Toronto, and No. 2 Red potatoes at Winnipeg. However, when data for certain months are not availabale, prices for other grades of potatoes were substituted. Such a procedure could bring about some inaccuracy in the final series.

Most of the data used in estimating the current version of the Potato model are from Statistics Canada. Some were detained directly from CANSIM Database, while import and export data were retrieved from the Trade-Tapes.

The FARM Data-Bank series were used for most exogenous variables. This is advantageous in view of the forecasting phase of the Potato model. Finally, a few series were obtained from "secondary" sources such as the farm price index of potatoes which came from J. Hynes, Agriculture Division, Statistics Canada.

Empirical Results

Both the annual (crop-year) and the quarterly versions of the Potato Forecasting Model were estimated over the period of 1972 to 1982, using the ordinary least squares (OLS) estimation technique. Note, however, that the OLS approach may suffer some limitation in the sense that it pre-supposes "non-simultaneity" in the model as a whole. A two-stage least squares (2SLS) approach would have been more appropriate in the "advent" of a simultaneity problem where it could have provided more efficient coefficients.

TABLE 7. ANNUAL (CROP YEAR) VERSION OF THE "POTATO FORECASTING MODEL" EMPIRICAL RESULTS FOR THE PERIOD - 1972 1st Q. TO 1981 4th Q.

1. Harvested Production, Western Canada:

QP01C = 571.28 - 1.16 FIPCOP3C(-1) + 38.70 TIME
(11.65) (2.31) (3.33)

2. Harvested Production, Central Canada:

QP02C = 1019.87 - 5.66 FIPI3C(-1) + 0.58 FPIP03C(-1) + 109.67 TIME
(6.45) (2.72) (1.99) (2.95)

3. Harvested Production, Atlantic Canada:

QP02AC = 992.48 + 69.54 TIME + 38.15 WPP03C(-1) - 2.10 FIPCOP3C(-1)
(7.83) (2.30) (2.24) (1.51)

4. Domestic Disappearance of Potatoes *by consumers and Processing Industry):

DP03C = 1518.00 - 35.77 WPP03C + 4.68 RPMT3C
(27.14) (3.63) (5.08)

5. Import Price for Table and Seed Potatoes:

IMPP03C = 0.28 + 0.36 ER34C + 0.37 IMPP03C(-1)
(1.46) (1.73) (1.08)

6. Wholesale Price for Table Potatoes:

WPP03C = 1.84 + 21.02 IMPP03C + 0.05 DEL(1: RPP03C)
(2.13) (3.85) (2.69)

7. Farm Price (index) for Potatoes:

FPIP03C = 16.03 + 34.40 DEL(1: WPP03C) + 0.95 FPIP03C(-1)
(0.31) (5.67) (4.60)

8. Cash Receipts from Potato Production:

CRP03C = 32.50 + 0.0004 FPIP03C*QP03C - 163.54 DEL(1: ER34C)
(2.03) (14.83) (1.27)

9. Total Imports of Seed and Table Potatoes:

IMP03C = 769.03 - 1086.52 ER34C + 0.26 DP03C + 26.97 TIME
(2.76) (3.55) (1.90) (3.10)

10. Total Exports of Seed and Table Potatoes:

EXP03C = 168.54 + 0.69 CRP03C(-1) + 0.10 QP03C(-1)
(0.76) (2.19) (1.08)

At this stage of empirical experimentation with the potato sector, an OLS approximation is preferable. Moreover due to the fact that some of the equations demonstrate recursive characteristics, the present estimation technique seems acceptable.

The results (including t - statistics) of the annual (crop-year) version of the model are acceptable (Table 6). The coefficient of determination (R^2), the Durbin-Watson (D.W.) and the overall test of significance of the regression (F-statistics) are also acceptable under regular econometric consideration (Table 7). For example most of the equations describe a good fit as demonstrated by the value of the R^2 and the F-statistics. The results for the quarterly version are presented separately in the Appendix and are not part of the current analysis.

Note that the statistics associated with the annual (crop-year) version have the most significant econometric meanings. The statistics: (R^2), (D.W.), (t-statistics) and (F-statistics) from the quarterly version are biased since most of the quarterly equations are "strictly" restricted to third quarter observations.

The results indicate that technical change (introduced in the model by a time trend variable) is a major factor for the production of potatoes in all three regions of Canada. The aggregate farm input price index is significant in Central Canada whereas it is the "farm price index for crop production" which is in Western as well as in Atlantic Canada, the relevant explanatory variable (in terms of cost of production).

Lagged prices for the output, in particular wholesale and farm prices for potatoes, are the key factors in the determination of harvested potato production. While the wholesale price appears as a significant factor for Atlantic Canada, it is farm price which affects production in Central Canada.

Finally none of the prices for the output seem significant as an explanatory variable for production in Western Canada. This is not surprising in view of the fact that potatoes are such a relatively minor crop in that region. Moreover, since potatoes are cultivated in conjunction with economically "stronger" crops (such as barley), Western Producers are far less sensitive to changes in the price of potato.

One of the characteristics of the Potato Forecasting Model is that both final and derived demand for potatoes (excluding demand for seed-use) are jointly estimated. The single equation for disappearance reflects the price (at the wholesale level) for potatoes and the retail price for a substitute (i.e. price of meat). Both variables are significant and present appropriate signs. It follows that an increase in the wholesale price for potatoes causes a decrease in total disappearance, whereas a similar increase in the retail price of meat leads, as expected, to a parallel increase in the domestic disappearance of potatoes.

For the import price of potatoes, (equation 5 in Table 6), the exchange rate variable is relatively more significant than the lagged endogenous variable. The signs are appropriate, but the t-statistics indicate that the two explanatory variables are not very significant. The exclusion of the U.S. potato variables from the model had a probable impact on the specification of equation 5. It seems that the omission of U.S. variables in that equation may have lead to some specification error.

Equation 6 is a price transmission relationship, which indicates that a change in the import price is automatically reflected at the wholesale level. Concurrently, changes in the retail price also appear to affect the level of the wholesale price for potatoes. Both explanatory variables show the expected signs and are statistically significant.

Similarly equation 7 was specified as a price transmission function. Changes in the wholesale price level seem to significantly affect prices at the farm level. The lagged endogenous variable has also a major impact on the behavior of farm prices for potatoes.

Cash-receipts from potatoes were estimated differently from the equation described in the FARM model. Since there is a strong link between the Canadian and the U.S. potato sectors and because in some parts of Canada a significant share of production is shipped south of the border, the value of the Canadian dollar vis-ã-vis the U.S. dollar affects the total cash-receipts from Canadian potatoes. It follows from the statistical results that an increase in the exchange rates does negatively affect total cash-receipts for potatoes. Parallel to that, farm price times total harvested production is highly significant and positively related to cash- receipts.

Quarterly estimations, because of the bias introduced at the specification level and the possibility that the statistical results may be misleading, are presented for illustrative purpose in the Appendix.

TABLE 8. REGRESSION STATISTICS (ANNUAL VERSION)

Endogenous Variable	R2	D.W.	F
QP01C	0.73	2.53	9.23
PQ02C	0.70	2.66	4.59
QP02AC	0.79	2.89	7.45
DP03C	0.79	1.47	13.21
IMPP03C	0.68	2.22	7.59
WPP03C	0.85	1.76	19.11
FPIP03C	0.82	1.70	16.15
CRP03C	0.97	2.51	110.24
IMP03C	0.68	1.72	4.32
EXP03C	0.51	2.11	3.58

Validation of the Potato Forecasting Model

Although most of the individual equations, presented earlier, indicate acceptable statistical and economic properties, it is necessary to see how the endogenous variables perform within the "global" framework of a model. The Potato Forecasting Model was subjected to two initial tests for validation. These tests were the within-sample simulation (ex post simulation). The extra-sample simulation (ex post forecasting).

The model was first simulated over the range of the first quarter 1972 to the fourth quarter of 1981. The main observation is that most components of the model perform very well, while several do not.

For example the mean percentage errors are under 1 per-cent in absolute terms for the endogenous variables comprising the production bloc and the total disappearance bloc as well as for the yearly variable of cash-receipts.

Similarly over the historical period, of 1st quarter 1972 to 4th quarter 1981, the Root Mean Squared Percentage Error (RMSPE) was less than 8% for all the variables in both the production and the disappearance blocs. A RMSPE of less than 20% was obtained for the following endogenous variables: total imports, import price (annual) and the discrepancy variable. The rest of the endogenous variables have their RMPSE between 25% to 30%.

The main "problem" appears in the price, cash-receipts and trade blocs. All the price variables have RMSPE's which fell between 18% and 31%. It should be noted that the model describes a group of price transmission equations led by the import price equation. Since the "leading equation" does not perform very well in the simulation mode, it is not surprising that the linked equations also demonstrate a relatively high RMSPE.

The situation, however, is manageable since the potential misspecification error was considered in the import price equation. In fact, by excluding U.S. variables from the model we "ignore" the close relationship between the Canadian and the U.S. potato sectors. Such an approach was retained because of the lack of forecasts on exogenous U.S. potato variables. By introducing a U.S. price factor as an additional explanatory variable, the price components of the model should improve significantly.

The next step in the validation process consisted of the "re-simulation" of the model over the extra-sample period of the first quarter 1982 to the fourth quarter 1984. The Mean Percentage Error (MPE) and the RMSPE measures are available for 16 variables, only the discrepancy variable has no extra-sample statistics. Of this total, 11 endogenous variables have MPE of less than 10 percent; 4 variables present a MPE of less than 20 percent but greater than 10 percent; the only major problem at this point is with the total imports variable with a MPE of 61.78 percent.

In terms of the RMSPE, 7 variables out of the total 16 post a value of less than 10 percent; 5 endogenous variables have their RMPSE greater than 10 percent but smaller than 20 percent; two variables have theirs between 20 and 25 percent. The main concern is the import variable, the latter was "overforecasted" by a significant margin with an RMSPE of approximately 62 percent for the period 1982 to 1984, this conforms with our previous analysis with regard to the misspecification of the trade components of the model.

The tendency of diverging simulation results in trade flows is not unique to the present Potato Forecasting model. Attempts to develop a Trade model (5) have shown a similar pattern of overforecasting imports and exports of potatoes. These results for trade in potatoes

TABLE 9. INTRA-SAMPLE (1ST Q. 1972 TO 4TH Q. 1981) AND EXTRA-SAMPLE (1ST Q. TO 4TH Q 1984) SIMULATION AND VALIDATION MEASURES OF THE "POTATO FORECASTING MODEL"

Endogenous Variable	Historical Period 1st Q. 1972 to 4th Q. 1981		Forecast Period 1st Q. 1982 to 4th Q. 1984	
	Mean Percentage Error	Root Mean Squared Percentage Error	Mean Percentage Error	Root Mean Squared Percentage Error
Production:				
QP01	0.31	5.66	10.66	11.94
QP02	-0.29	7.49	12.17	24.98
QP02A	0.76	7.14	-3.82	6.75
QP03	0.28	4.69	3.16	9.99
Disappearance:				
DP03C	0.10	4.14	8.95	8.95
DP03	-0.098	5.67	6.07	9.38
Prices:				
IMPP03C	3.16	18.01	18.28	18.28
IMPP03	5.94	24.74	12.94	21.19
WPP03C	5.15	24.72	-7.51	12.67
WPP03	9.47	31.70	-1.21	18.62
FPIP03C	-1.74	23.90	3.65	3.65
FPIP03	1.38	28.89	7.76	12.90
Cash Receipts:				
CRP03C	-0.96	31.49	-1.47	1.47
CRP03	1.75	33.72	1.94	14.39
Trade:				
IMP03C	1.42	16.16	61.78	61.78
EXP03C	2.83	27.58	7.09	7.09
Discrepancy:				
DISCP03C	2.85	16.10	N/A	N/A

simply imply that non-economic factors play an essential and determining role in the evolution of these variables. Although, there is, at this stage, no clear-cut explanation for the divergent results, a review of the specification of imports, exports and import price equations with the commodity specialists is considered.

Assessment of the Potato Forecasting Model

The model was developed with a primary objective to provide forecasts. Albeit a few problems in some components, with "questionable" structural characteristics, the global performance indicates that the model can generate reliable forecasts for some key variables in the potato industry.

Moreover, the potential sources of some of the difficulties encountered have been identified. For example, both imports and exports were subjected (over part of the historical period of the analysis) to some trade restrictions; in fact the U.S. had applied some quotas on the imports of Canadian potatoes in the North-Eastern market, and similarly tariffs were imposed to some degree on U.S. potatoes entering part of the Candadian market. However, these trade constraints do not appear in the current version.

The exclusion of U.S. variables from the model was mentioned, on various occasions, as a potential problem. Moreover, in the data analysis, critical questions with regard to some variables were raised. For example, commercial inventory was dropped because no data are available for the third and for part of the fourth quarter.

In light of all these "specific" limitations, special efforts should concentrate on re-specification of the model. The creation of a Potato Forecasting Model is an initial step and that more testing and analysis are required with regard to a better understanding of the dynamic structure of the industry. This same structure might be used to assess the seed sector and possible the processing sector.

Areas of focus should also include some data revision; the redefinition of import price, import and export equations; and the re-assessment of the price transmission equations. Since the model is going to be used as a forecasting tool, new ideas and concepts could be tested along the line. The continuous use of the Potato Forecasting Model appears as a "pragmatic way" to reduce if not eliminate the inaccuracies encountered previously. Closer examination of the links between the Canadian and U.S. potato sectors should improve the global forecasting ability of the model. Macro-economic variables (as explanatory parameters) should be integrated into the model, in order to increase the analytical basis of the derived forecasts.

The linkage between annual and quarterly framework can be improved by using other variables than lagged endogenous variables to explain the quarterly differences. Similarly the linkages among the equations in the model should be more "tightly" connected, in order to reflect the simultaneous characteristic of the model's equations.

7. FOOTNOTES

(a) In Western and Atlantic Canada, crops represent the main agricultural activities, thus "Farm input price index for crops" is used to determine the level of potato production in thse two areas. Whereas in Central Canada, agricultural activities are more diversified and potatoes are competing with a broader range of production activities, therefore "Total farm input price index for all production" is considered as an explanatory variable of potato production.

(b) Due to a lack of data, only the exchange rates and the lagged endogenous variable are used as the sole factors determining the import prices of potatoes - this equation needs to be re-specified on a broader basis.

(c) It appears that total aggregate imports of potatoes into Canada are not sensitive to price factors; therefore such variables were excluded from the specification. However, it is recognized that if prices of imported potatoes are "very" high this will have an effect on total imports.

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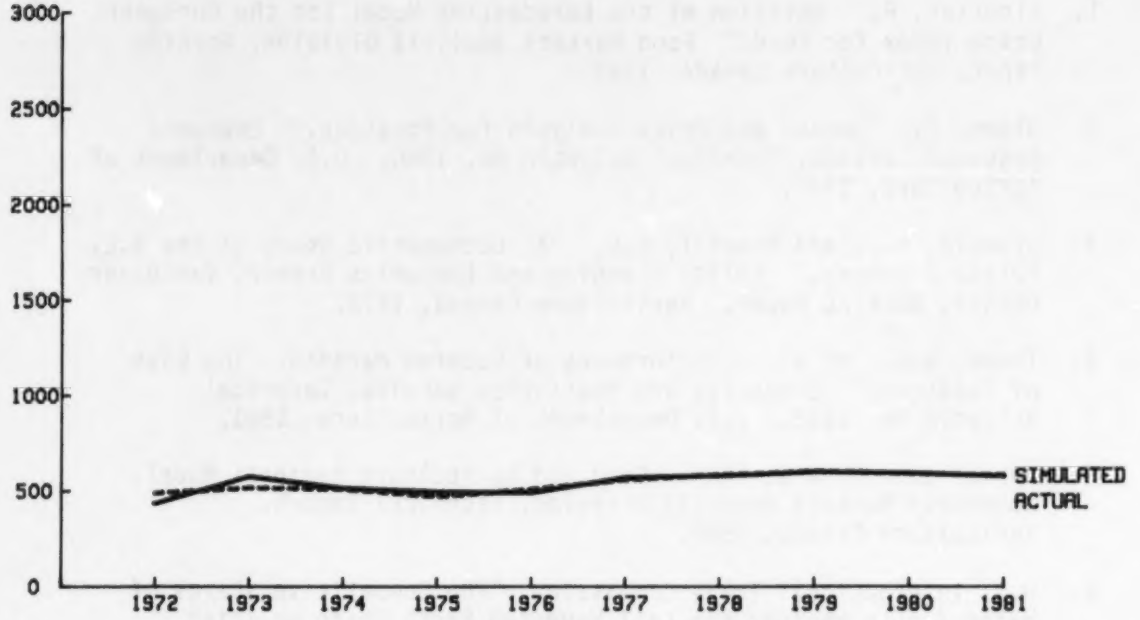
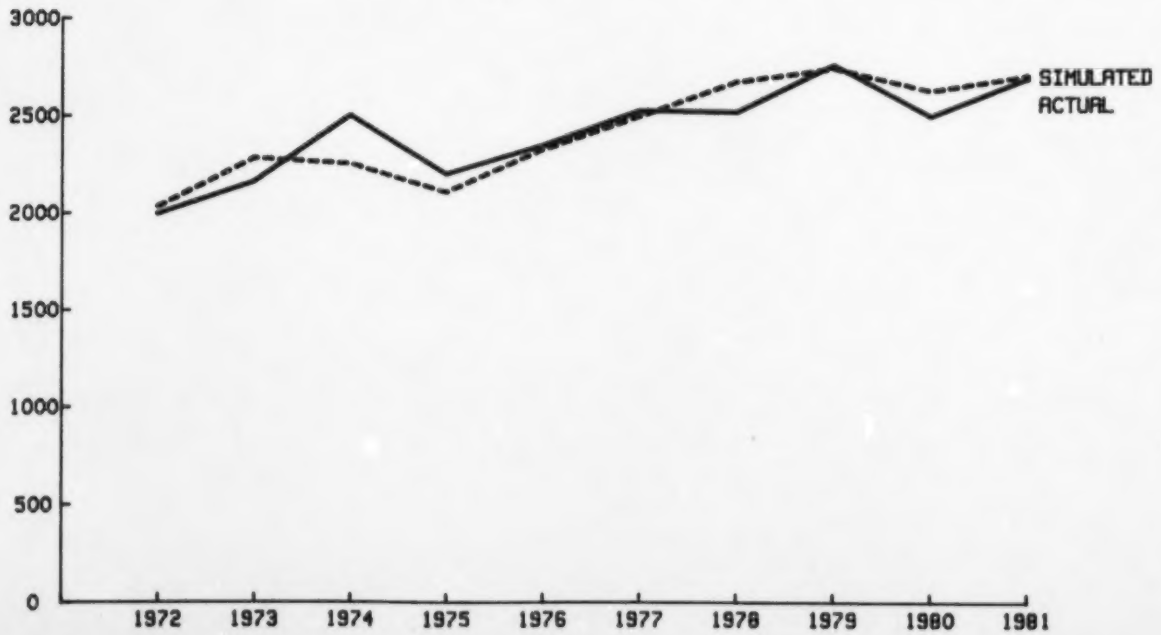
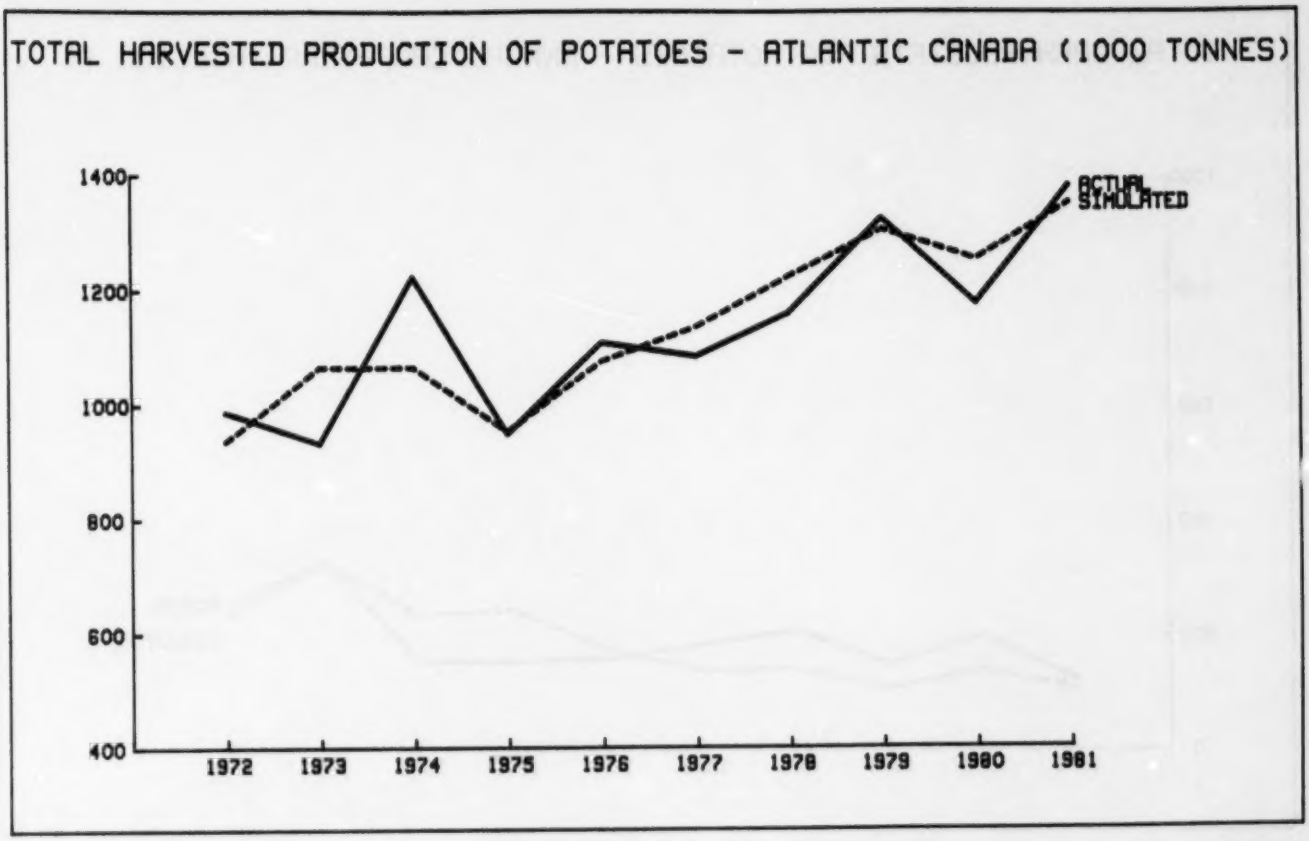
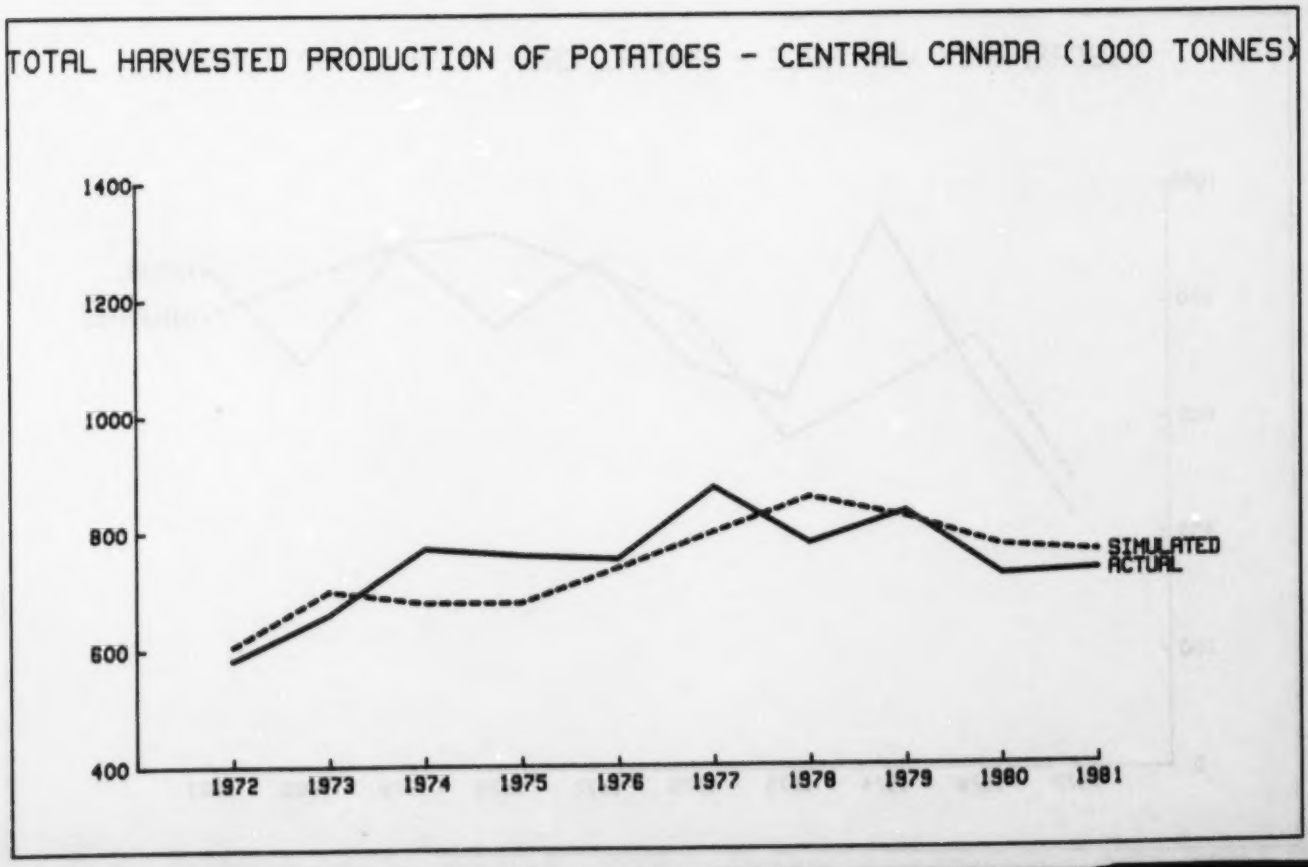
TOTAL HARVESTED PRODUCTION OF POTATOES - WESTERN CANADA (1000 TONNES)

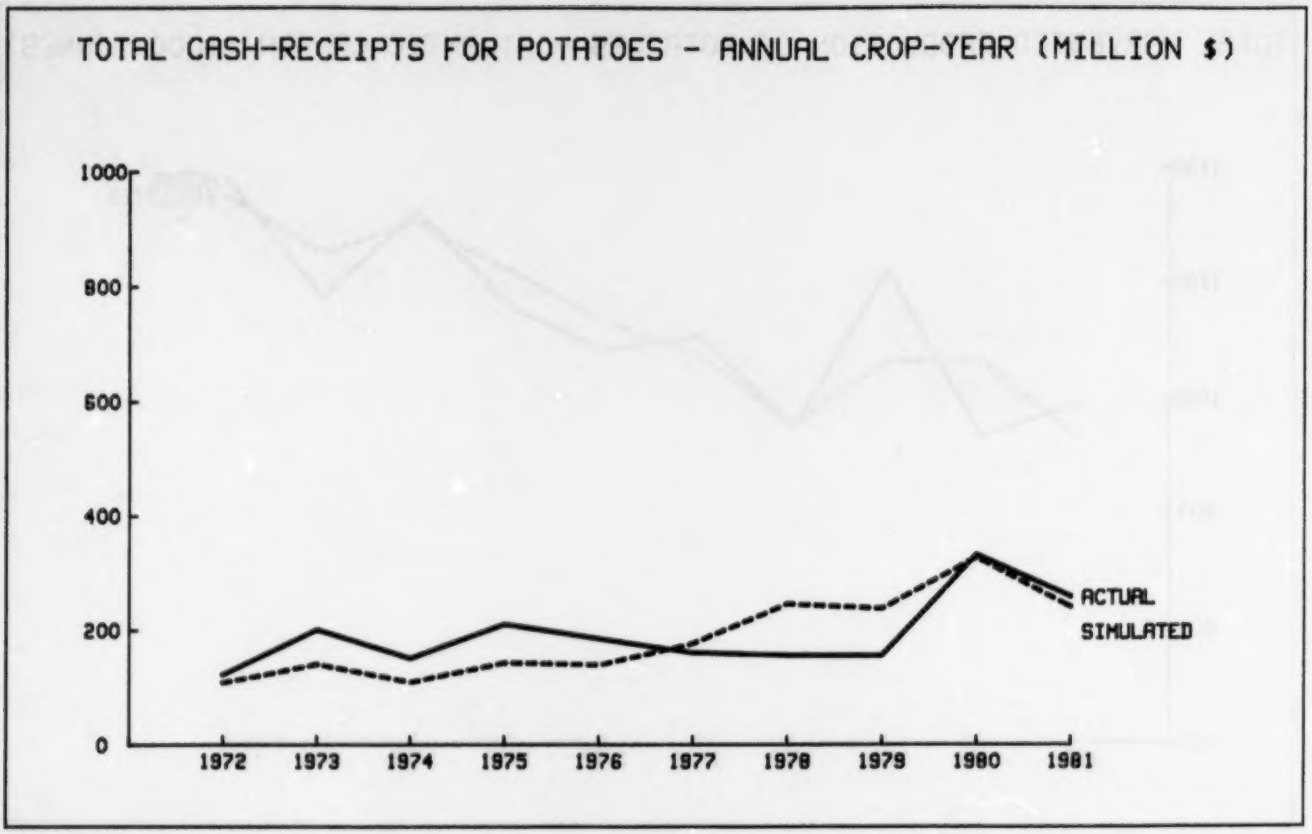


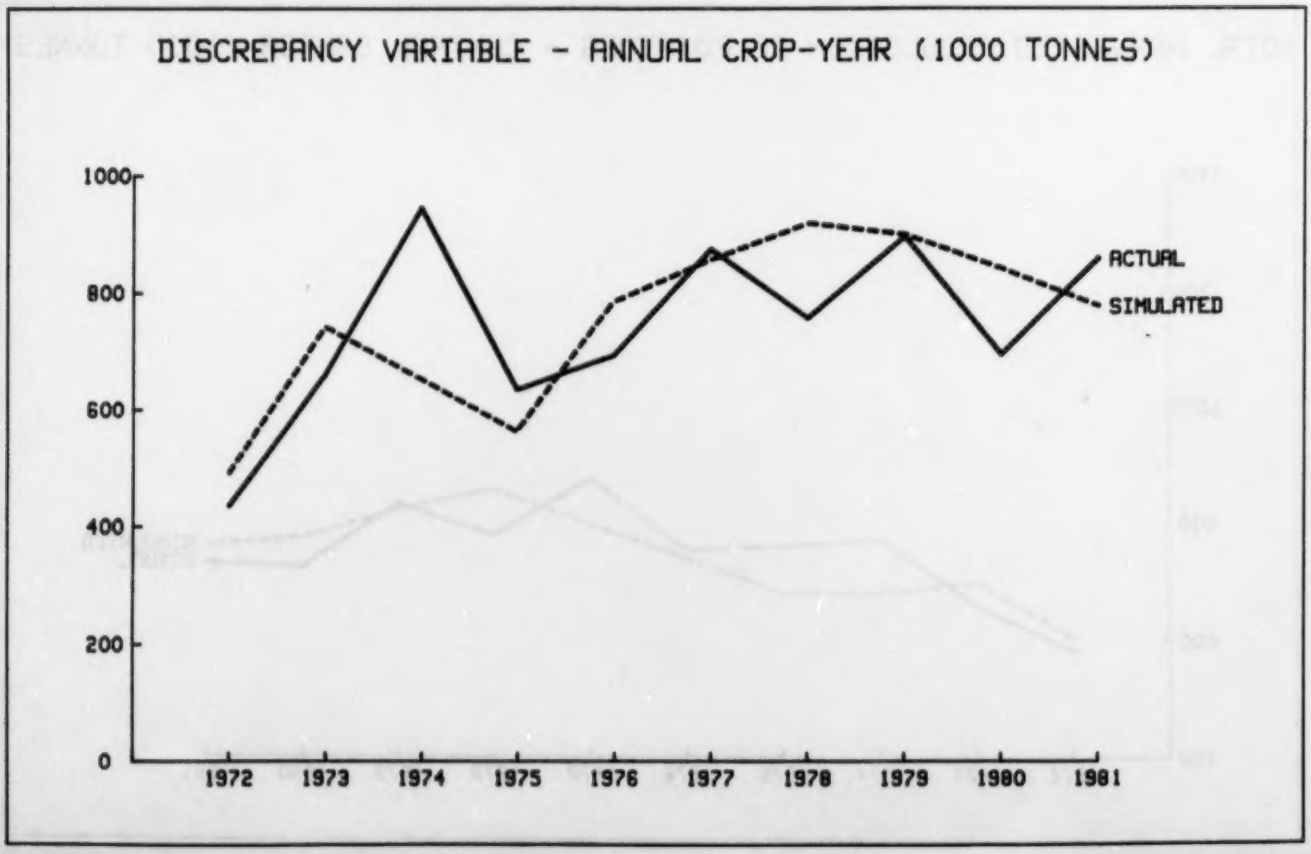
TOTAL HARVESTED PRODUCTION OF POTATOES - CANADA (ALL) (1000 TONNES)

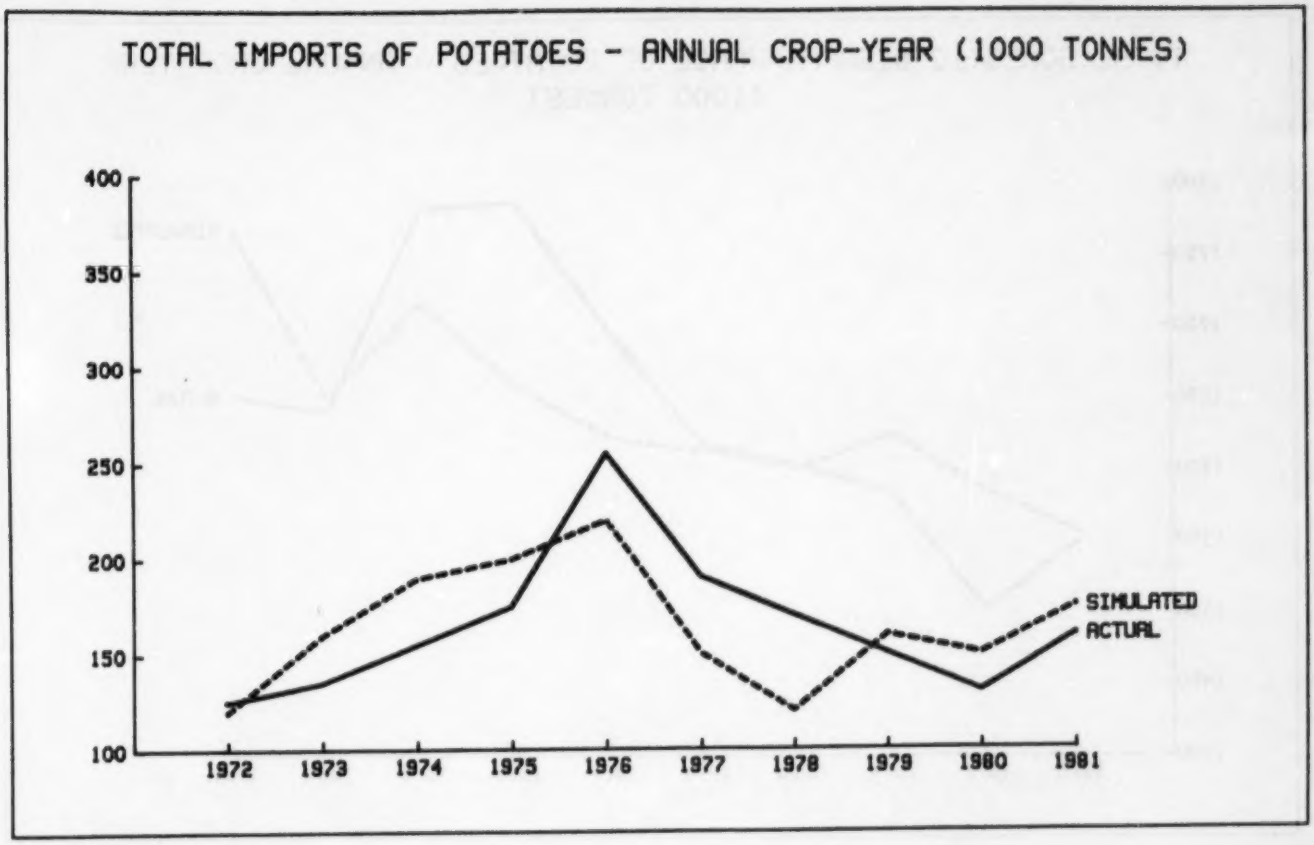


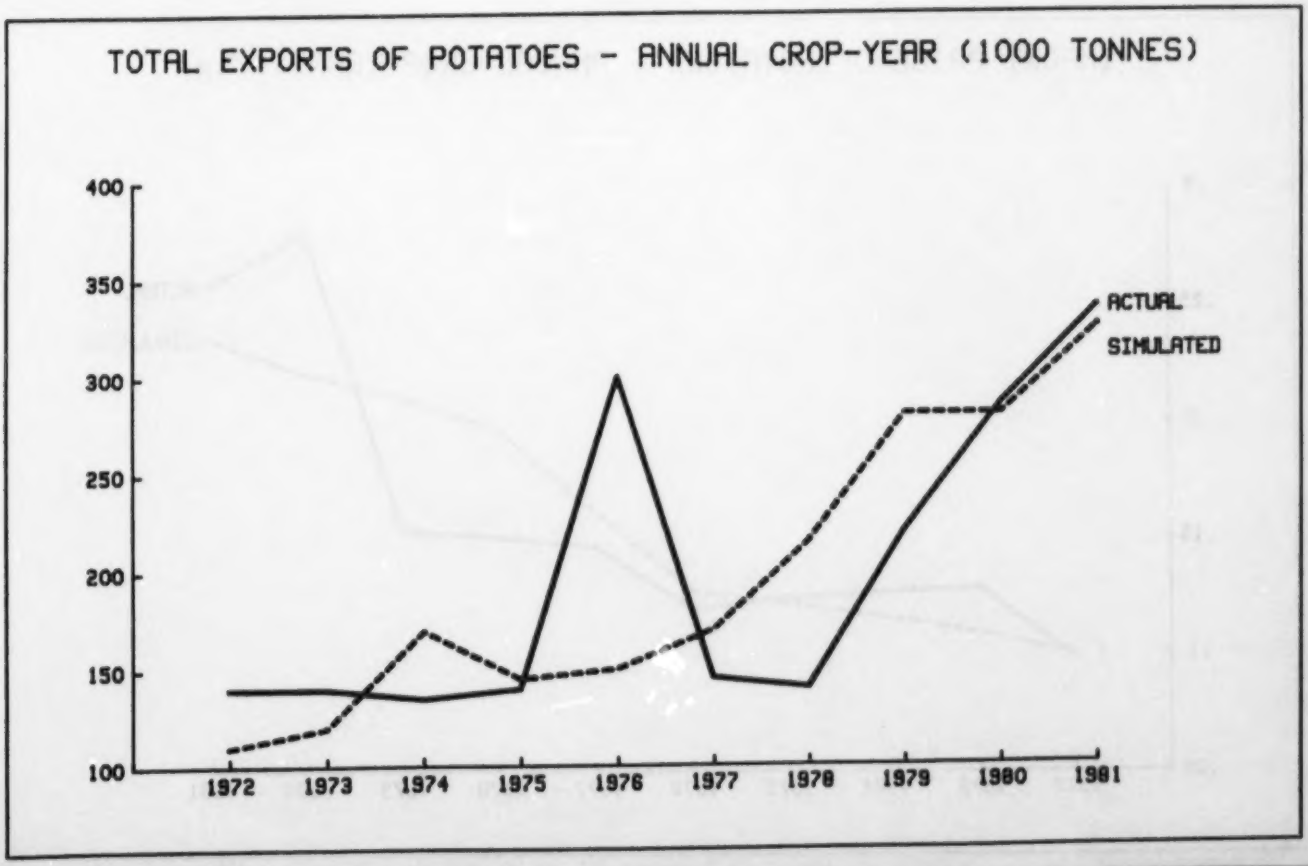

TOTAL HARVESTED PRODUCTION OF POTATOES - ATLANTIC CANADA (1000 TONNES)
1400
1200
1000
800
600
400
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED


TOTAL HARVESTED PRODUCTION OF POTATOES - CENTRAL CANADA (1000 TONNES)
1400
1200
1000
800
600
400
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
SIMULATED
ACTUAL

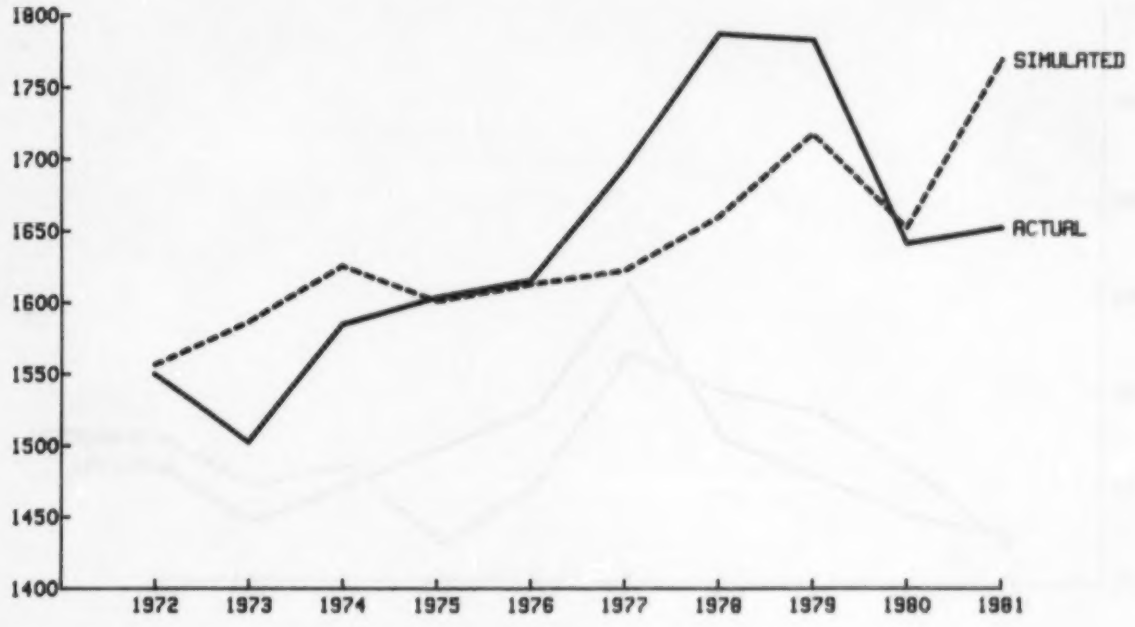

TOTAL CASH-RECEIPTS FOR POTATOES - ANNUAL CROP-YEAR (MILLION $)
1000
800
600
400
200
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED


DISCREPANCY VARIABLE - ANNUAL CROP-YEAR (1000 TONNES)
1000
800
600
400
200
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED

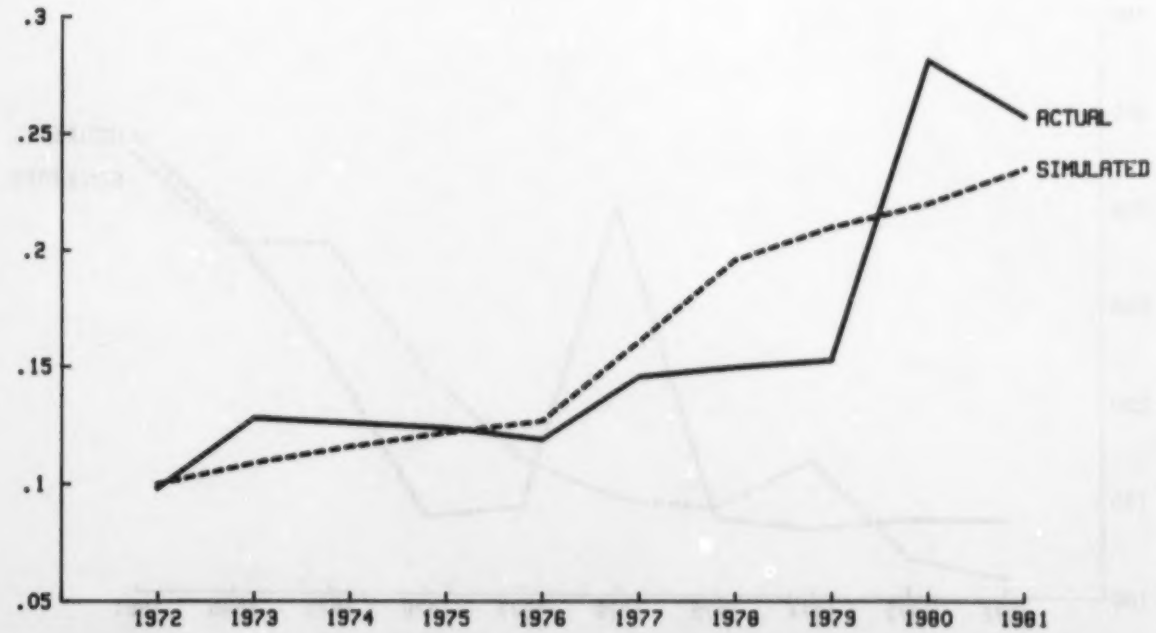

TOTAL IMPORTS OF POTATOES - ANNUAL CROP-YEAR (1000 TONNES)
400
350
300
250
200
150
100
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
SIMULATED
ACTUAL


TOTAL EXPORTS OF POTATOES - ANNUAL CROP-YEAR (1000 TONNES)
400
350
300
250
200
150
100
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED

TOTAL DOMESTIC DISAPPEARANCE OF POTATOES - ANNUAL CROP-YEAR
(1000 TONNES)

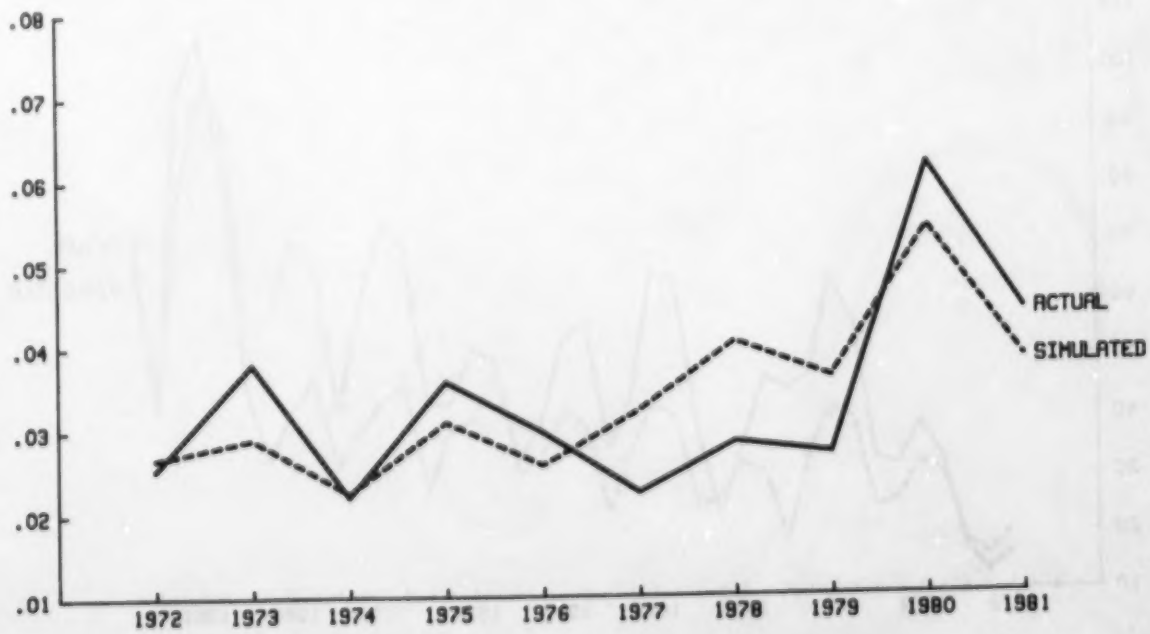


IMPORT PRICE OF POTATOES - ANNUAL CROP-YEAR ($/kg)

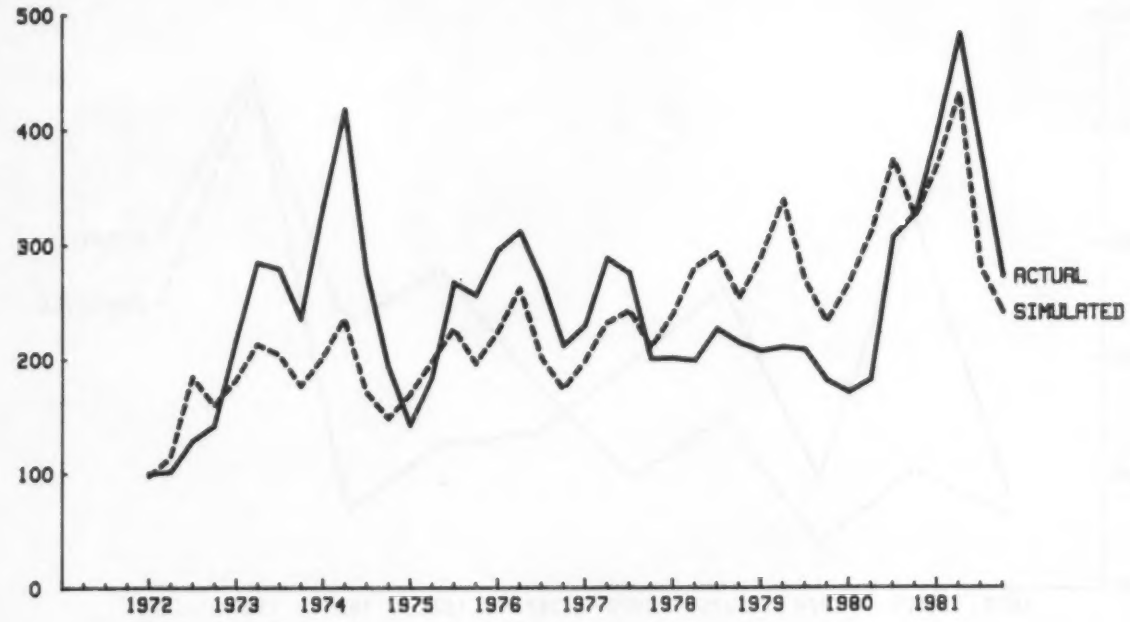


FARM PRICE INDEX FOR POTATOES - ANNUAL CROP-YEAR (1971=100)

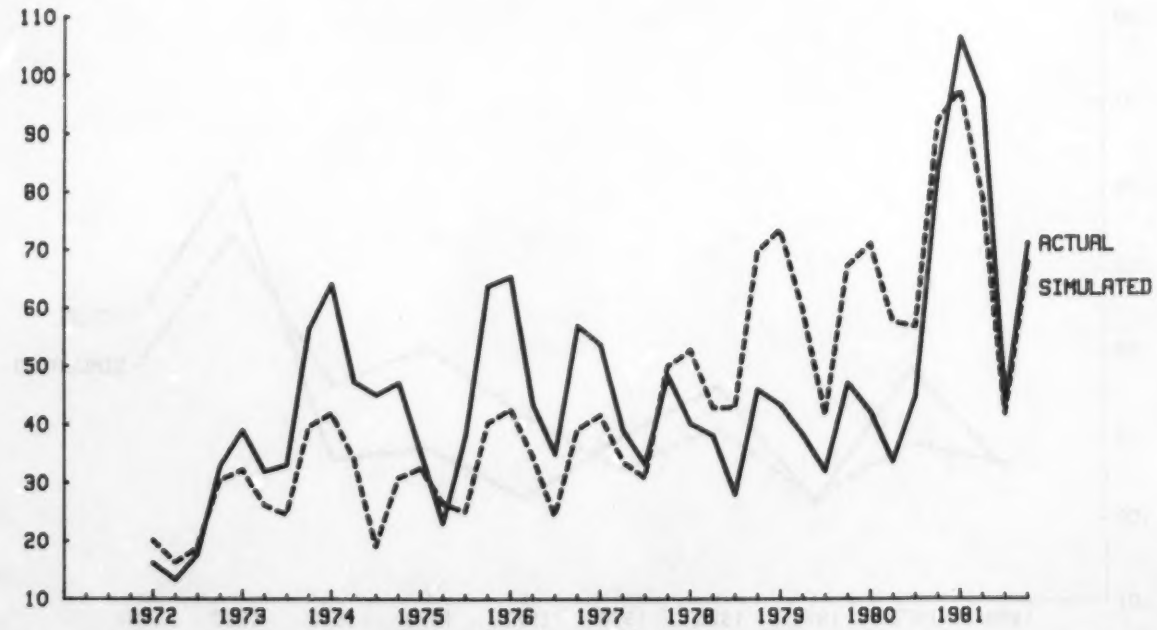
WHOLESALE PRICE FOR POTATOES - ANNUAL CROP-YEAR ($/kg)

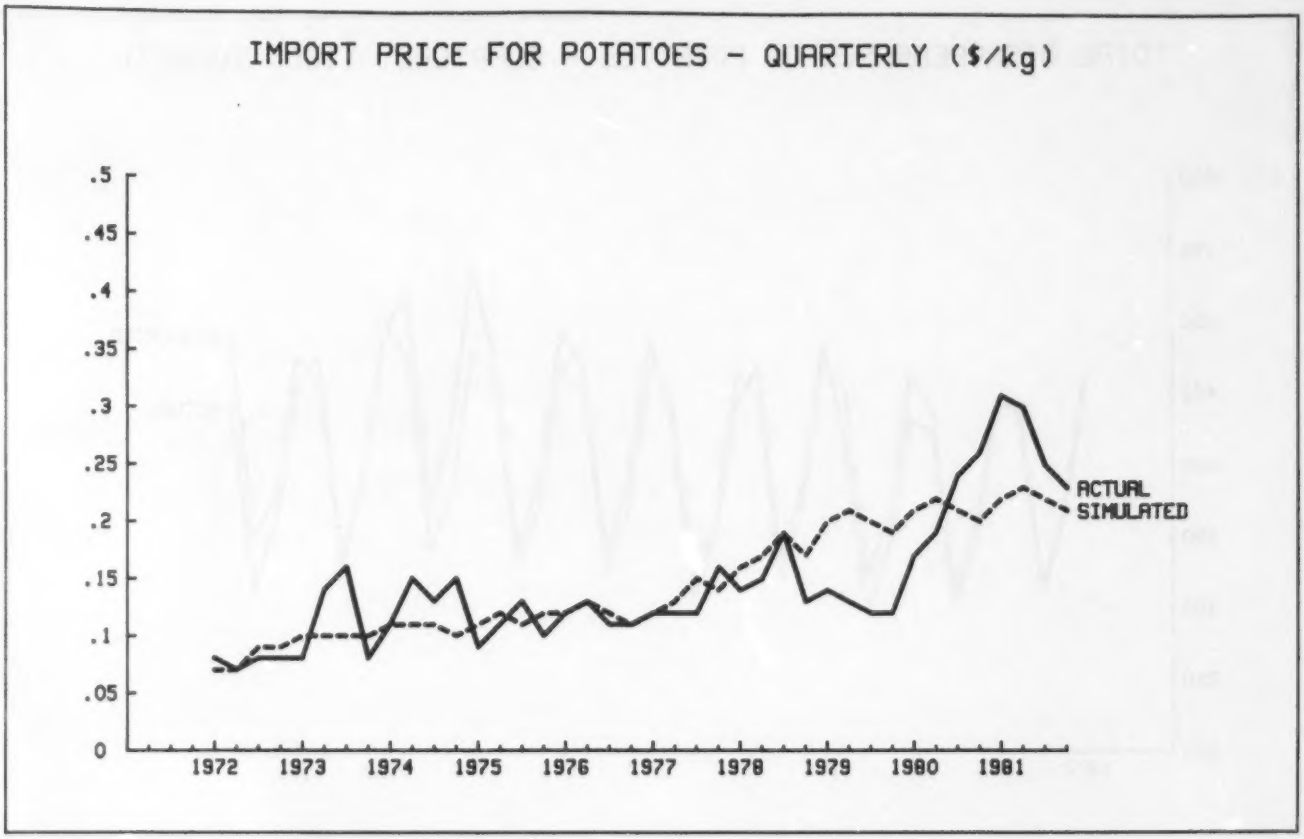


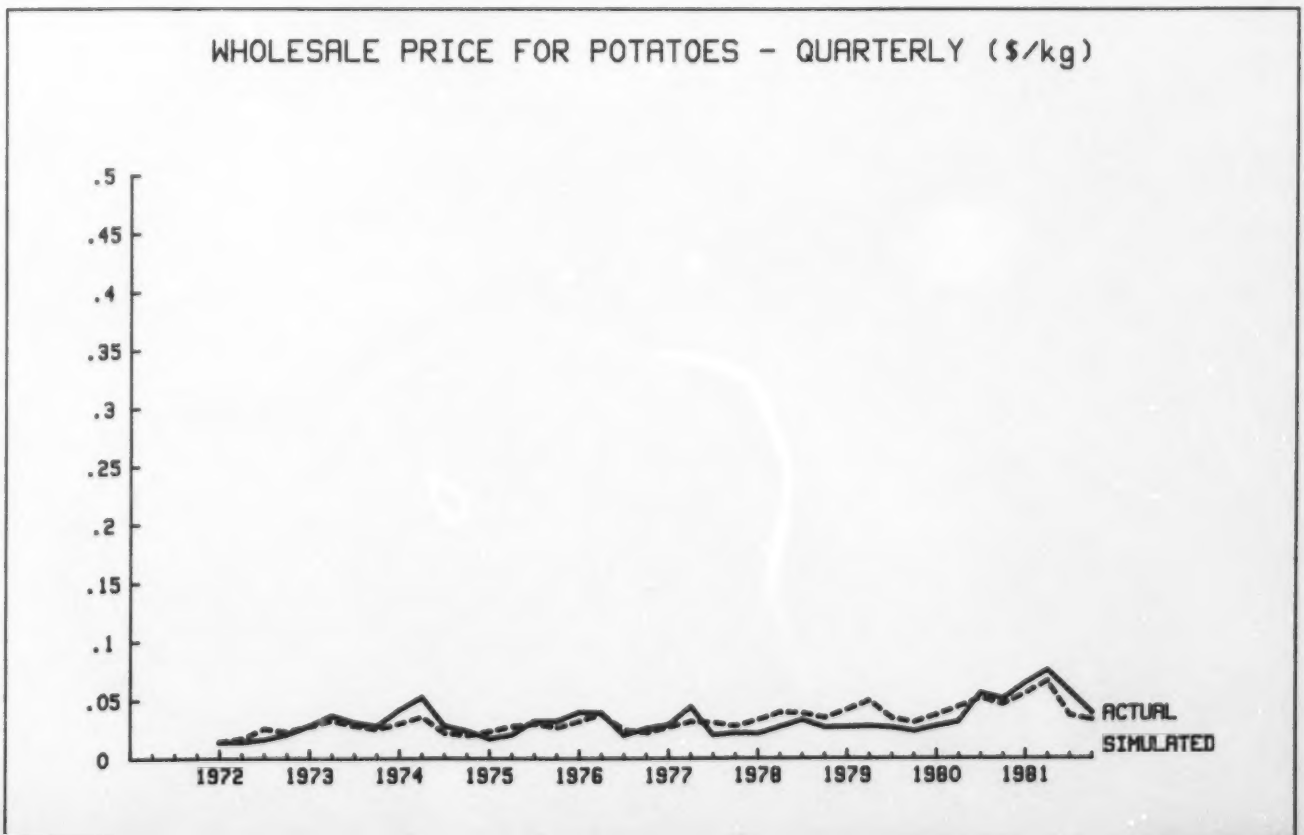
FARM PRICE INDEX FOR POTATOES - QUARTERLY (1971=100)

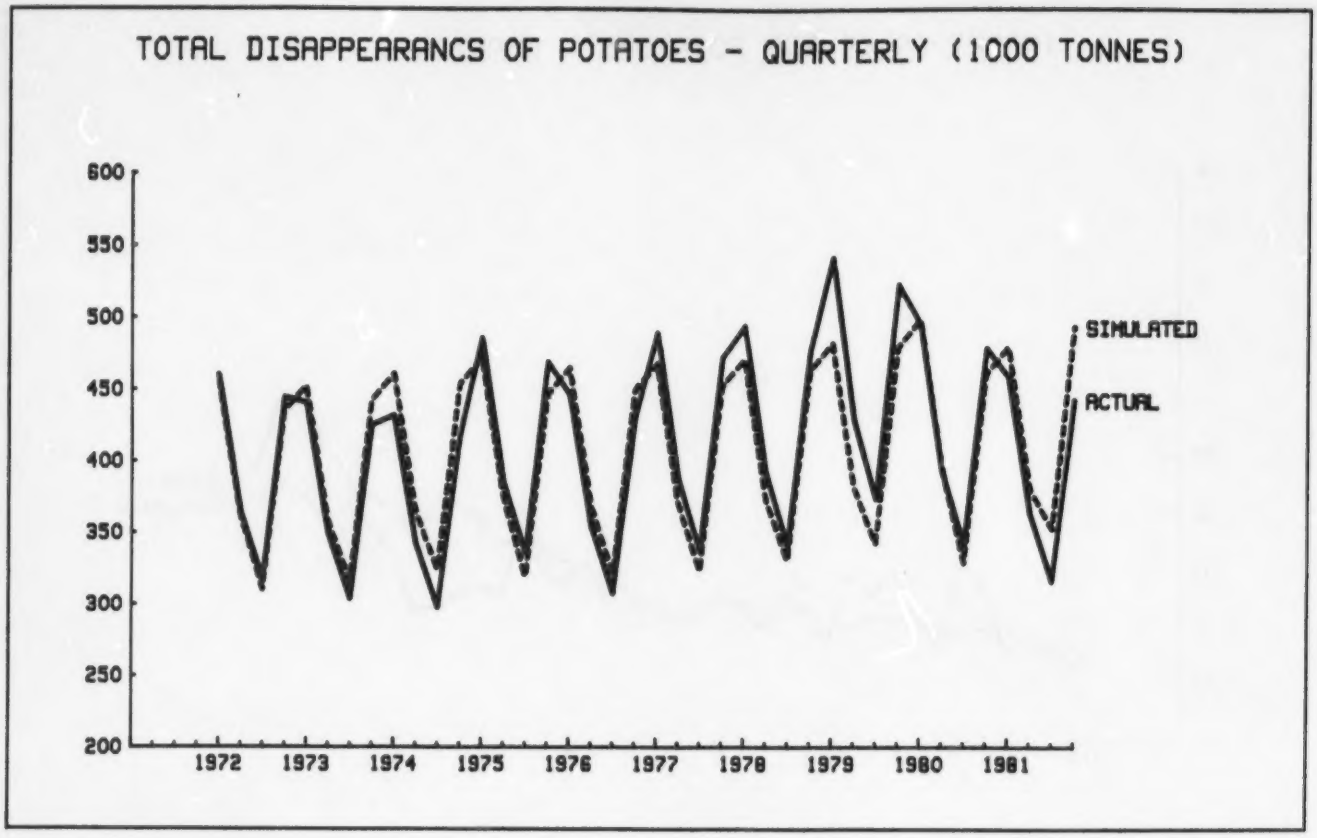


TOTAL CASH-RECEIPTS FOR POTATOES - QUARTERLY (MILLION $)




IMPORT PRICE FOR POTATOES - QUARTERLY ($/kg)
.5
.45
.4
.35
.3
.25
.2
.15
.1
.05
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED


WHOLESALE PRICE FOR POTATOES - QUARTERLY ($/kg)
.5
.45
.4
.35
.3
.25
.2
.15
.1
.05
0
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
ACTUAL
SIMULATED


TOTAL DISAPPEARANCS OF POTATOES - QUARTERLY (1000 TONNES)
600
550
500
450
400
350
300
250
200
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
SIMULATED
ACTUAL

(APPENDIX II)

TABLE 1. SYMBOLS AND DEFINITION OF THE VARIABLES USED IN THE CURRENT VERSION OF THE POTATO MODEL

Endogenous Variables

CRP03	- Total cash receipts for potatoes, Canada, Quarterly, (million $). Source: CORDATA1.
CRP03	- Total cash receipts for potatoes, Canada, Crop Year, (million $). Source: CORDATA1.
DISCP03C	- Discrepancy variable, (i.e., demand for seed, cullage, ...), Canada, Crop-Year, (thousand metric tonnes). Derived series.
DP03	- Total domestic disappearance of fresh potatoes, (i.e., demand from consumers plus derived demand from processing industry), Canada, Quarterly, (thousand metric tonnes). Source: CANSIM - Statistics Canada.
DP03C	- Total domestic disappearance of fresh potatoes, (i.e., demand from consumers plus derived demand from processing industry), Canada, Crop-Year, (thousand metric tonnes). Source: CANSIM - Statistics Canada.
EXP03C	- Total exports of fresh potatoes (i.e., both table and seed), Canada, Crop-Year, (thousand metric tonnes). Source: Trade Tapes, Statistics Canada.
FPIP03	- Farm Price index for potatoes, Canada, Quarterly, (1971=100). Source: Agriculture Division - Statistics Canada.
IMP03C	- Total imports of fresh potatoes (i.e., both table and seed), Canada, Crop-Year, (thousand metric tonnes). Source: Trade-Tapes, Statistics Canada.
IMPP03C	- Import price for potatoes, Canada, Crop-Year ($/kilogram). Derived series.
QP01	- Total harvested production of potatoes, Western Canada, Crop-Year (thousand metric tonnes). Source: Statistics Canada.

- continued -

(APPENDIX II)

TABLE 1. (Cont'd)

QPO2	- Total harvested production of potatoes, Central Canada, crop-year (thousand metric tonnes). Source: Statistics Canada.
QPO2A	- Total harvested production of potatoes, Atlantic Canada, Crop Year, (thousand metric tonnes). Source: Statistics Canada.
QPO3	- Total harvested production of potatoes, Canada, Crop-Year, (thousand metric tonnes).
WPPO3	- Average wholesale price for Canadian potatoes, Quarterly, Montreal/Toronto No. 1 White and Winnipeg No. 2 Red, ($/75 lbs.). Source: Agriculture Canada - Market Information Division.
WPPO3C	- Average wholesale price for Canadian potatoes, Crop-Year, Montreal/Toronto No. 1 White and Winnipeg No. 2 Red, ($/75 lbs.). Source: Agriculture Canada - Market Information Division.
Exogenous Variables	
ER34C	- Canadian vs. U.S. exchange rates, Crop-Year, ($ Can./$U.S.). Source: FARM Databank.
EXPPO3C	- Export price for potatoes, Canada, Crop-Year, (1971=100). Source: FARM Data Bank.
JS1	- Seasonal dummy, 1 for the first quarter, zero otherwise.
JS2	- Seasonal dummy, 1 for the second quarter, zero otherwise.
JS3	- Seasonal dummy, 1 for the third quarter, zero otherwise.
JS4	- Seasonal dummy, 1 for the fourth quarter, zero otherwise.
RPMT3C	- Retail price for meat, poultry and fish, Canada, Crop-Year, (1971=100). Source: CANSIM. Statistics Canada; Agriculture Canada - Food Market Analysis Division.

- continued -

(APPENDIX II)

TABLE 1. (Conclusion)

RPPO3C	- Retail price for potatoes, Canada, Crop-Year, (1971=100). Source: CANSIM - Statistics Canada; Agriculture Canada - Food Markets Analysis Division.
TIME4	- A time trend variable.
FIPCOP3C	- Farm input price index for crop production, Canada, Crop-Year, (1971=100). Source: CANSIM - Statistics Canada.
FIPI3C	- Farm input price index, all, Canada, Crop-Year, (1971=100). Source: CANSIM - Statistics Canada.

TABLE 1. QUARTERLY VERSION OF THE "POTATO FORECASTING MODEL" EMPIRICAL RESULTS FOR THE PERIOD 1972 - 1ST Q. TO 1981 4TH Q.

---

1. Harvested Production, Western Canada:

QP01 = JS3*(571.28 - 1.16 FIPCOP3C(-4) + 38.70 TIME4)
(26.79) (5.32) (7.66)

2. Harvested Production, Central Canada:

QP02 = JS3* (1019.87 - 5.66 FIPI3C(-4)) + 0.58 FPIP03C(-4) + 109.67 TIME4)
(15.80) (6.68) (4.87) (7.23)

3. Harvested Production, Atlantic Canada:

QP02A = JS3* (992.48 + 69.54 TIME4 + 38.15 WPP03C(-4) - 2.10 FIPCOP3C(-4))
(19.19) (5.64) (5.50) (3.71)

4. Domestic Disappearance of Potatoes (by Consumers and Processing Industry):

DP03C = JS3* (1518.00 - 35.77 WPP03C + 4.68 RPMT3C)
(62.40) (8.34) (11.67)

5. Import Price for Table and Seed Potatoes:

WPP03C = JS3* (0.28 + 0.36 ER34C + 0.37 IMPP03C(-4))
(3.36) (3.97) (2.48)

6. Wholesale price for Table and Seed Potatoes:

IMPP03C = JS3*(1.84 + 21.02 IMPP03C + 0.05 DEL(4: RPP03C))
(4.89) (8.85) (6.19)

7. Farm Price (index) for potatoes:

FPIP03C = JS3* (16.03 + 34.41 DEL(4: WPP03C) + 0.95 FPIP03C(-4))
(0.72) (13.04) (10.56)

8. Cash Receipt from Potato Production:

CRP03C = JS3* (-32.50 + 0.0004 FPIP03C*QP03C - 163.53 DEL(4: ER34C))
(4.67)(34.08) (2.92)

9. Total Imports of Seed and Table Potatoes:

IMP03C = JS3* (769.03 - 1086.52 ER34C + 0.26 DP03C + 26.97 TIME4))
(6.76) (8.68) (4.65) (7.60)

10. Total Exports of Seed and Table Potatoes:

EXP03C = JS3* (-168.54 + 0.69 CRP03C(-4) 0.10 QP03(-4))
(1.74) (5.04) (2.48)

- continued -

TABLE 1. (Concluded)

11. Import Price for Table and Seed Potatoes:

$$\underset{}{IMPP03} = \underset{(24.29)}{0.98*(JS3*IMPP03C)} + \underset{(22.80)}{0.92*(JS4*IMPP03C(-1)} + \underset{(22.47)}{1.02*(JS1*IMPP03C(-2))} + \underset{(23.96)}{1.09*(JS2*IMPP03(-3))}$$

12. Wholesale Price for Table Potatoes:

$$\underset{}{WPP03} = \underset{(21.56)}{0.96*(JS3*WPP03C)} + \underset{(19.27)}{0.85*(JS4*WPP03C(-1))} + \underset{(21.49)}{1.03*(JS1*WPP03C(-2)} + \underset{(25.55)}{1.22*(JS2*WPP03C(-3))}$$

13. Cash Receipts from Potatoes:

$$\underset{}{CRP03} = \underset{(16.44)}{0.17*(JS3*CRP03C)} + \underset{(26.65)}{0.28*(JS4*CRP03C(-1))} + \underset{(25.92)}{0.30*(JS1*CRP03C(-2))} + \underset{(21.03)}{0.24*(JS2*CRP03C(-3))}$$

14. Farm Price (index) for Potatoes:

$$\underset{}{FPIP03} = \underset{(21.75)}{1.00*(JS3*FPIP03C)} + \underset{(18.79)}{0.87*(JS4*FPIP03C(-1))} + \underset{(20.09)}{0.99*(JS1*FPIP03C(-2))} + \underset{(23.54)}{1.16*(JS2*FPIP03C(-3))}$$

15. Domestic Disappearance of Potatoes (by Consumers and Processing Industry):

$$\underset{}{DP03} = \underset{(62.13)}{0.20*(JS3*DP03C)} + \underset{(86.98)}{0.28*JS4*DP03C(-1))} + \underset{(90.11)}{0.29*(JS1*DP03C(-2))} + \underset{(71.47)}{0.23*(JS2*DP03C(-3))}$$

(APPENDIX III)

TABLE 2. REGRESSION STATISTICS (QUARTERLY VERSION)

Endogenous Variable	R2	D.W.	F
QP01	0.996	2.00	5381.96
QP02	0.996	2.00	2713.42
PQ02A	0.996	2.00	2676.89
DP03C	0.999	2.00	2.31E + 0.4
IMPP03C	0.952	2.00	370.31
WPP03C	0.979	2.00	848.32
FPIP03C	0.987	2.00	1440.81
CRP03C	0.997	2.00	5407.45
IMP03C	0.982	2.00	661.47
EXP03C	0.918	2.00	206.15
IMPP03	0.88	2.03	89.25
WPP03	0.89	1.60	92.42
CRP03	0.89	1.59	96.40
FPIP03	0.81	1.32	49.68
DP03	0.94	1.45	197.20

(APPENDIX IV)

TABLE 1. SUPPLY AND DISPOSITION, POTATOES, CANADA, 1966/67 TO 1982/83

Crop-Year	Production	Imports	Total Supply	Exports	Discrepancy[1]	Food and industrial use
			- thousand tonnes -			
1966/67	2,480.2	81.3	2,561.5	214.7	922.2	1,424.6
1967/68	2,119.6	111.4	2,231.0	115.1	630.6	1,485.3
1968/69	2,398.2	101.4	2,499.6	194.8	805.8	1,499.0
1969/70	2,351.6	98.6	2,450.2	203.9	726.3	1,520.0
1970/71	2,500.3	95.0	2,595.3	123.2	964.0	1,508.1
1971/72	2,219.4	96.7	2,316.1	111.1	633.1	1,571.9
1972/73	1,966.8	124.6	2,121.4	137.2	434.5	1,549.7
1973/74	2,162.8	136.7	2,299.5	137.6	659.9	1,502.9
1974/75	2,503.7	154.7	2,658.4	130.0	943.9	1,584.5
1975/76	2,198.5	174.3	2,372.8	134.9	634.6	1,603.3
1976/77	2,346.8	249.9	2,596.7	288.4	693.1	1,615.2
1977/78	2,524.8	186.3	2,711.1	142.6	873.4	1,695.1
1978/79	2,513.3	165.5	2,678.8	136.7	755.1	1,787.0
1979/80	2,752.4	146.2	2,898.6	221.2	894.9	1,782.5
1980/81	2,470.7	129.9	2,617.5	283.4	693.8	1,640.3
1981/82	2,683.2	158.9	2,842.1	331.9	858.5	1,651.7
1982/83	2,799.0	111.8	2,910.8	265.7	1,014.9	1,630.2

[1]Includes net trade of precessed potatoes, seed-use plus cullage.

Source: Statistics Canada (1) Production: CANSIM matrix 1044 and "Fruit and Vegetable Production" (#22-003). (2) Imports and Exports: Statistics Canada Trade Tapes.

(APPENDIX IV)

TABLE 2. AREA, YIELD AND PRODUCTION, POTATOES, CANADA, 1969/61 TO 1982/83

Crop-Year	Area (thousands hectares)	Yield (tonnes/ hectare)	Production (thousand tonnes)
1960/61	118.01	16.41	1,936.66
1961/62	123.71	16.17	2,000.70
1962/63	116.27	18.29	2,126.35
1963/64	115.78	18.05	2,089.29
1964/65	112.22	19.13	2,146.99
1965/66	119.54	17.37	2,076.82
1966/67	129.05	19.22	2,480.20
1967/68	122.90	17.25	2,119.59
1968/69	122.70	19.55	2,398.19
1969/70	123.51	19.04	2,351.56
1970/71	127.80	19.56	2,500.33
1971/72	109.14	20.34	2,219.38
1972/73	98.50	20.27	1,996.80
1973/74	105.08	20.58	2,162.77
1974/75	113.83	22.00	2,503.74
1975/76	104.79	20.98	2,198.51
1976/77	106.83	21.97	2,346.79
1977/78	111.97	22.55	2,524.78
1978/79	110.49	22.75	2,513.31
1979/80	112.79	24.40	2,752.35
1980/81	106.43	23.37	2,487.59
1981/82	110.52	24.28	2,683.18
1982/83	113.31	24.70	2,799.03

Source: Statistics Canada, CANSIM matrix 1044 and "Fruit and Vegetable Production", (#22-003). For conversion factors, see Tables 1 and 2 respectively on page 4 and page 6.

(APPENDIX V)

TABLE 1. MODEL FORECASTS FOR SOME ENDOGENOUS VARIABLES, 1984

	1984 1st Q.	1984 2nd Q.	1984 3rd Q.	1984 4th Q.	Crop-Year 1983/84
Total Disappearance DP03	498.39	395.27	365.12	511.16	1833.55
Import Price IMPP03	0.26	0.28	0.25	0.23	0.25
Wholesale Price WPP03	9.02	10.73	6.76	6.04	7.07
Farm Price FPIP03	352.71	413.19	295.18	255.00	292.77
Cash Receipts CRP03	102.13	82.87	53.63	86.94	308.15
Production (Western) QP01	N/A	N/A	N/A	N/A	690.60
Produciton (Central) QP02	N/A	N/A	N/A	N/A	885.98
Production (Atlantic) QP02A	N/A	N/A	N/A	N/A	1538.92
Total Production (Canada) QP03	N/A	N/A	N/A	N/A	3115.49

NOTE: DP03, QP01, QP02, QP02A and QP03 are in thousand tonnes; IMPP03 is in ($/kilograms); WPP03 is in ($/75 lbs.); CRP03 is in (million $); and FPIP03 is an index = (1971 = 100).

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